AUGUST, 1949
Vol. 5 ---- No. 4

Lubrication ENGINEERING

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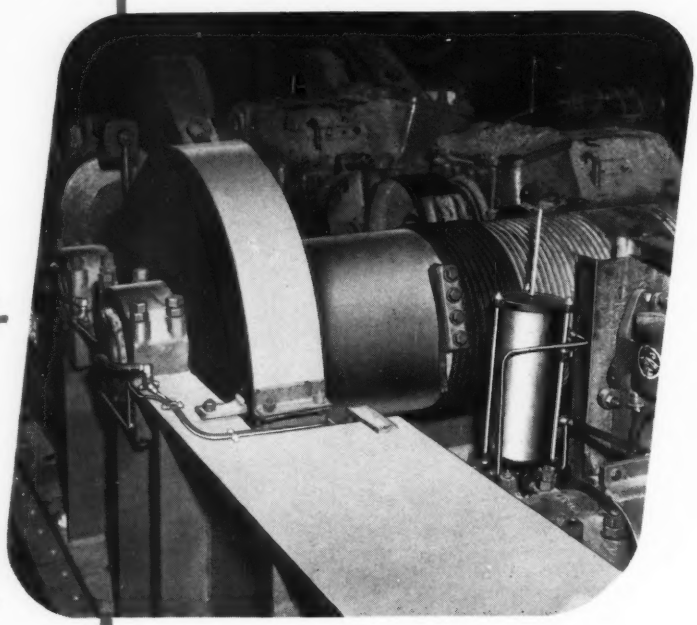
JOURNAL OF THE AMERICAN SOCIETY OF LUBRICATION ENGINEERS

NOW! **Trabon** **GIVES YOU**

Simple Positive Automatic Lubrication for *Crane Trolleys Crane Bridges*



Automatic 3400 Series Pumps can be driven from the drive shaft on the bridge or the drum or intermediate shaft on the trolley. They start and stop with the machinery. The more lifts—the more lubrication!

Check these Advantages of Trabon Automatic Crane Lubrication

- ✓ ***SAFE***—Eliminates Hazardous Hand Lubrication
- ✓ ***FAST***—No Down-Time for Manual Lubrication
- ✓ ***POSITIVE***—No Skipped or Forgotten Bearings
- ✓ ***SIMPLE***—Single Indicating Point at the Pump Tells the Whole Story —All-Hydraulic System is Sealed from Pump to Bearing

Mills in Ohio, Kentucky, Illinois and Pennsylvania have already installed Trabon Automatic Centralized Lubrication Systems on crane trolleys and bridges. The success of these automatic systems in eliminating the hazard of hand lubrication, in obtaining better bearing performance and in making the entire lubricating job simpler, easier and more positive is attested to by the repeat orders in plants where trial installations were made.

Write or call your nearest Trabon representative today for more information on these cost-reducing, trouble-eliminating lubricating systems.

Trabon ENGINEERING CORPORATION

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Centralized Oil and Grease Systems

with D. A. STUART CUTTING FLUIDS

THERE are several reasons why it pays to give more than ordinary attention to selection of cutting fluids. Experience has shown that such attention can, more often than not, achieve these results:

1. **Longer Tool Life.**
2. **Better Finish.**
3. **Greater Output per Machine.**
4. **Less Scrap Loss.**
5. **Reduction in Number of Different Oils and Blends Required.**

●

These benefits add up to Lower Operating Costs.

D. A. Stuart Oil Co. is prepared to help you *stretch your machining dollar* by the soundly engineered application of superior cutting fluids. Ask to have your nearby D. A. Stuart Oil Co. representative call to *prove* this statement. Send for D. A. Stuart literature.

"WISE ECONOMY RESULTS FROM WISE SELECTION OF CUTTING FLUIDS"

STUART *service goes with every barrel*

D.A. Stuart Oil CO.

2729-53 South Troy St., Chicago 23, Illinois

Lubrication ENGINEERING

VOL. 5 AUGUST, 1949 NO. 4

In This Issue

The Editor's Page 157

Lubrication of Railway Rolling Stock — William M. Barr 168

Progress in Instrument Lubrication — Henry Gisser 175

Some Aspects of Diesel Cylinder Lubrication — E. B. Watson 180

Discussions on Paper — "Improved High-Speed Roller Bearings" (June, 1949 LUBRICATION ENGINEERING) 184

New Products and Equipment 185

Current Literature 187

News of the Sections 189

Section Officers 190

Patent Abstracts, Oils and Lubricants 199

A.S.L.E. Hi-Lites 201

Publications — A.S.L.E. 202

Advertisers' Index 204

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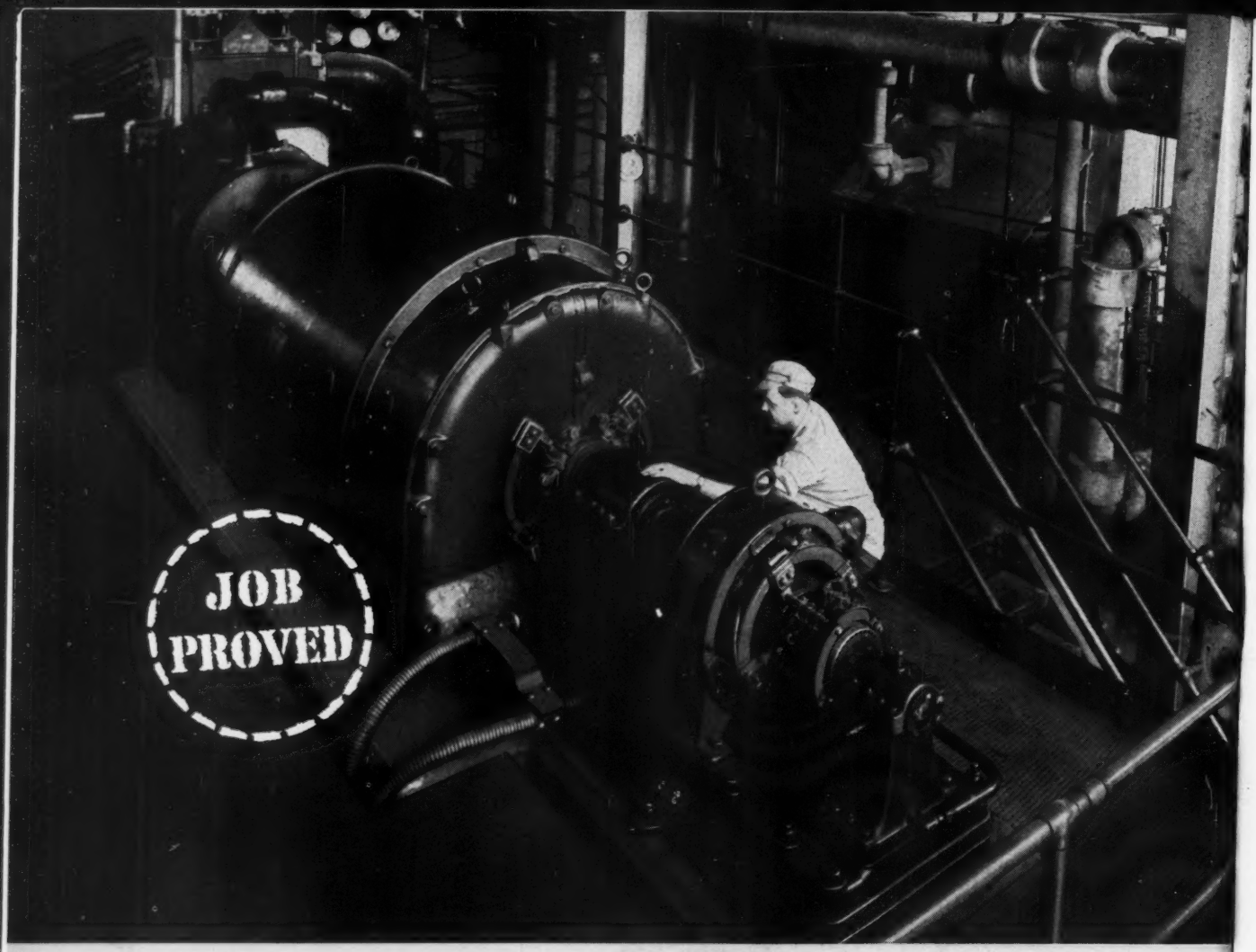

PROTECTED BY SUNVIS 916

Turbine Bearings and Journals Corrosion-Free Despite Summer Shutdowns — Oils Like New After 9,000 Hours

Three years ago, a paper mill overhauled a steam turbine. Thereafter, it was planned to operate this equipment on a 'round-the-clock schedule during the six winter months, and completely shut down in the summer. On the advice of a Sun Engineer, the mill charged the circulating system supplying turbine, generator journals, and governor with Sunvis 916. This oil was chosen because of its "Job Proved" ability to prevent rust and corrosion and to give troublefree lubrication for a long period of time.

The management's selection of Sunvis 916 proved to be sound. After 9,000 hours, a laboratory analysis of the oil showed it to be unchanged—comparable to a sample of new oil. Even more important, inspection showed no abnormal wear and no corrosion in bearings and journals, despite the summer-long shutdown.

The turbine has now operated 12,000 hours without oil-change, and it appears that none will be necessary in the foreseeable future.

All oils in the Sunvis 900 series have a high viscosity index, are fortified against oxidation and sludging, and prevent rust and corrosion. Sunvis 900 Oils are the finest lubricants available for turbines, hydraulic systems, and similar applications. For a free, illustrated booklet on Sunvis 900 Oils, write Department L-8.

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SUN PETROLEUM PRODUCTS

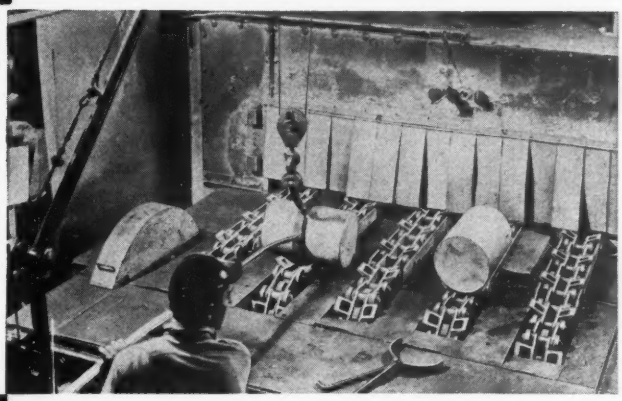
"JOB PROVED" IN EVERY INDUSTRY

SUNOCO

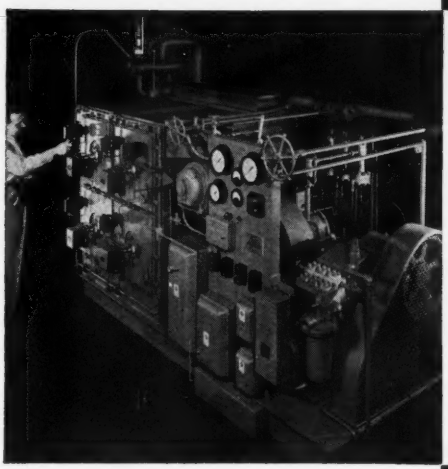
too much Heat?...too much Seizure?...

too much Solvent for Oil?

Lubricate with dag COLLOIDS colloidal graphite...



Right—Link-Belt conveyor chains carry aluminum billets for annealing at 900°F. Ideal application for "dag" Colloidal Graphite.



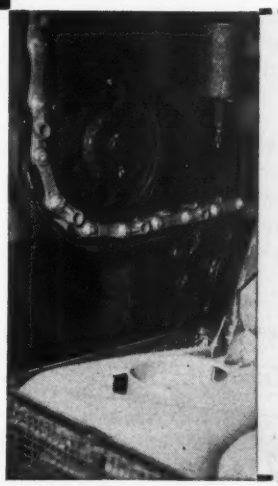
When you can lubricate once a month instead of twice a day, the savings are obvious.

"dag" Colloidal Graphite dispersions often make such savings possible where chemical conditions, rough service, or both extremes of temperature are the foes of easy movement.

Lubricating conveyors, ventilator fans, automatic plating machines, degreaser chains, chills, forging and stamping dies, are among 157 uses we can quote in which **"dag"** Colloidal Graphite has solved vexing maintenance or production problems.

If you'd like to see the growing list of 157 current uses, alphabetically arranged, just sign and mail the coupon.

Above—"dag" Colloidal Graphite used for high temperature lubrication of screw threads on high pressure steam systems of Besler Corporation.



Right—Degreaser chains for conveying base castings of Hoover vacuum cleaners are lubricated with "dag" Colloidal Graphite.

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H-12

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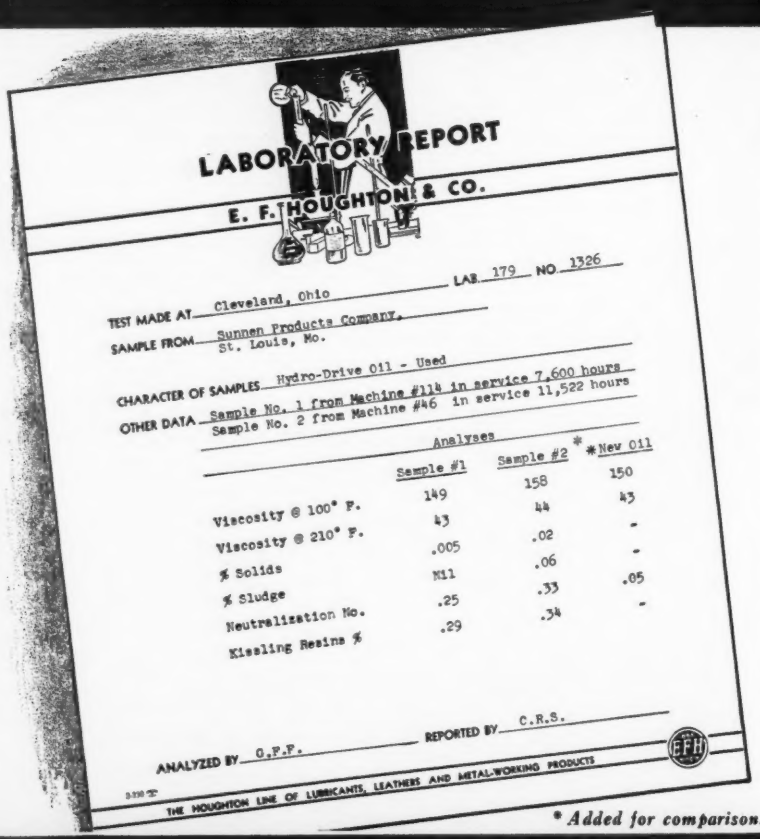
gets more than 3 years' use from one filling of Hydro-Drive Hydraulic Oil!

ANALYSIS SHOWED NO HARMFUL SLUDGE, RESINS OR ACID FORMATION...



LABORATORY REPORT

E. F. HOUGHTON & CO.

TEST MADE AT Cleveland, Ohio LAB. 179 NO. 1326

SAMPLE FROM Sunnen Products Company, St. Louis, Mo.

CHARACTER OF SAMPLES Hydro-Drive Oil - Used

OTHER DATA Sample No. 1 from Machine #114 in service 7,600 hours
Sample No. 2 from Machine #46 in service 11,522 hours

	Analyses		
	Sample #1	Sample #2	*New Oil
Viscosity @ 100° F.	149	158	150
Viscosity @ 210° F.	43	44	43
% Solids	.005	.02	-
% Sludge	Nil	.06	-
Neutralization No.	.25	.33	.05
Kissling Resins %	.29	.34	-

ANALYZED BY G.F.F. REPORTED BY C.R.S.

THE HOUGHTON LINE OF LUBRICANTS, LEATHERS AND METAL-WORKING PRODUCTS

*Added for comparison.

Long service under severe operating conditions, such as in die casting machines, is assured — when you use Houghton's "fortified" hydraulic oil.

This careful check, made at the request of Sunnen Products Co., proves the value of using an oil which has been treated for oxidation stability, gum solvency and corrosion prevention. Note from the laboratory report that viscosity was almost unchanged after three years' constant usage, and that sludge, resin content or acidity have not increased to any harmful extent.

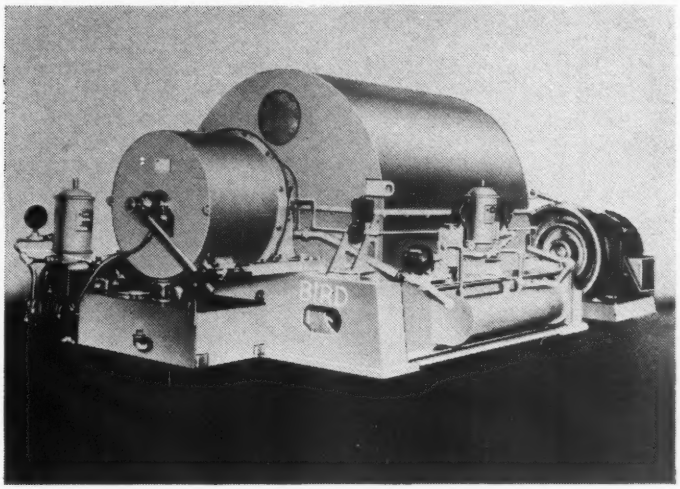
We recommended after this analysis that the oil be kept in service for another six months. Safe, accurate drain periods can thus be established — another Houghton service available to users.

No wonder so many concerns have standardized on Hydro-Drive. May we quote on *your* needs, and assure you of longer, trouble-free hydraulic oil service?

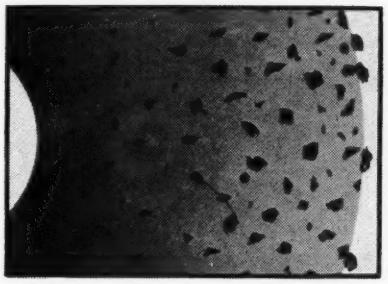
E. F. HOUGHTON & CO.

303 West Lehigh Avenue, Philadelphia 33, Pa.

Bird Machine Co., South Walpole, Mass. planned on providing the Bird Continuous Centrifugal Filter with one pint of extra heavy oil a minute to each main bearing and five gallons a minute of a pressure lubricant to the gear drive. And to make sure of *always-clean* oil, they specified Cuno MICRO-KLEAN Filters—guaranteed not to pass any solids larger than specified, exclusively constructed for double dirt capacity and minimum pressure drop. (Primary filtering is done by Cuno AUTO-KLEAN Filters—all-metal disc-type).



You're "Lube-Sure" with this Double-life Protection



Guaranteed Fluid Conditioning ... Double Cartridge Life

Cuno is the only manufacturer of replaceable-cartridge filters *guaranteeing* to remove all solids larger than specified, plus a large proportion down to 1 micron. MICRO-KLEAN's exclusive "graded-density-in-depth" permits smaller particles to penetrate to varying depths, eliminates surface loading, *doubles dirt holding capacity*. Resinous impregnation and polymerization prevents channeling, rupturing, shrinking and distortion.

Wide Range of Applications

Cuno MICRO-KLEAN filters come in varying densities . . . capacities from a few to more than 800 gpm . . . connections from ⅜ in. IPS to 6 in. flanged . . . single or multiple cartridges to handle full flow. MICRO-KLEAN cartridges fit other makes; special lengths available for built-in installations.

● Your nearby Cuno engineering representative, handling the broadest line of fluid filters, is your best source of unbiased recommendations on fluid filtration . . . he offers you, before and *after* installation, service based on years of experience with engineering filtration systems.

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Cuno Engineering Corporation
122 S. Vine St., Meriden, Conn.

Please send information on Cuno Filter.

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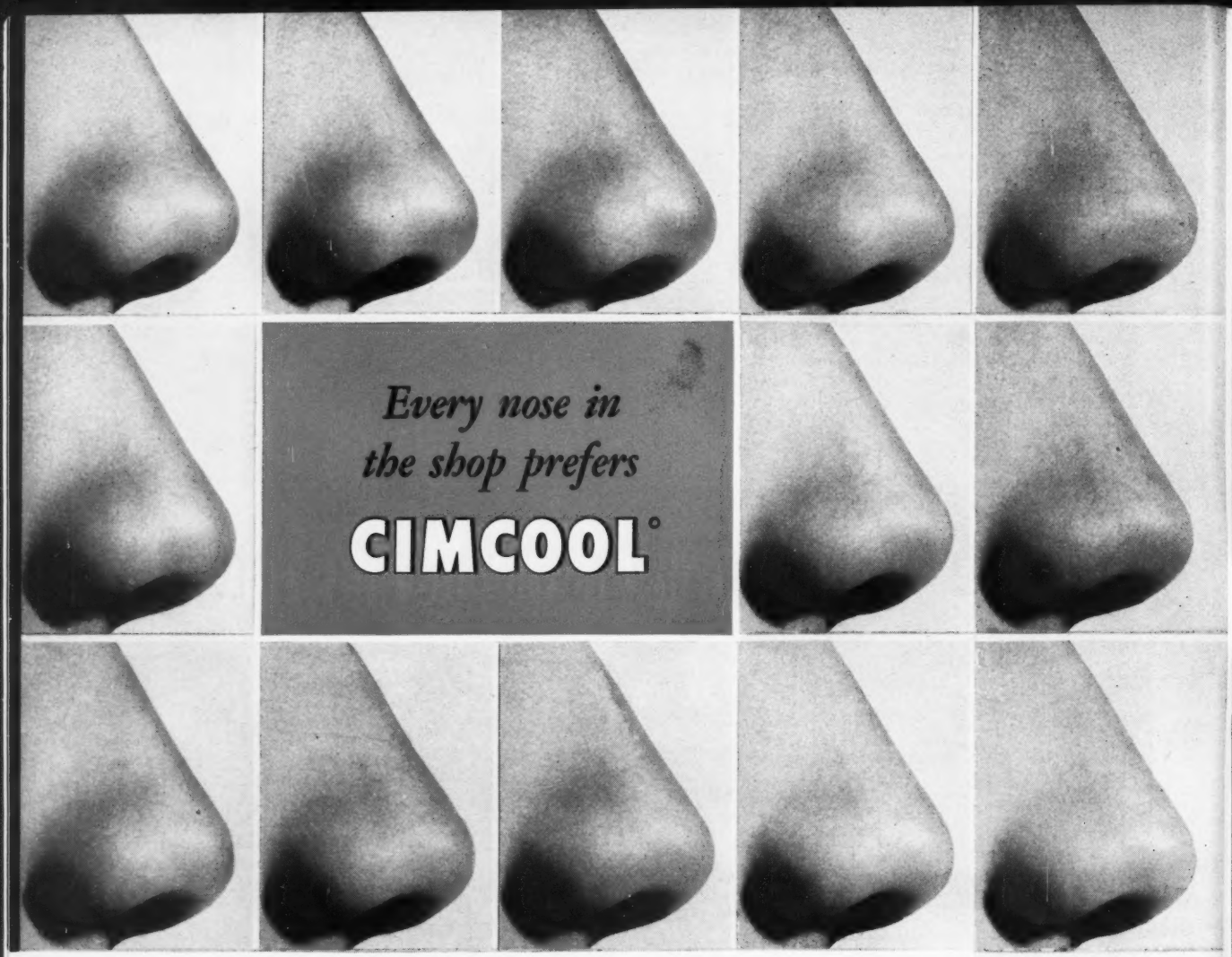

Every nose in the shop prefers

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WHY? Because Cimcool—a revolutionary cutting fluid—virtually eliminates rancidity and foul odors. Even *in the hottest weather.*

Cimcool is a *chemical emulsion* that has no objectionable odor of its own. And it can't burn, can't smoke.

But that's not the only difference between Cimcool and old-fashioned cutting fluids. Operators also like Cimcool because it's clean to work with, doesn't soil hands or clothes and contains no skin irritants. Leaves no hazardous slippery film on the hands, machine, work or floor. And Cimcool cools so fast that tools and chips actually stay cool to the touch. You'll find your operators like their jobs better when Cimcool is on the job. And *you'll* get better production.

Write for free booklet, "CIMCOOL Gives the Answers". Address, Sales Manager CIMCOOL Division, The Cincinnati Milling Machine Company, Cincinnati 9, Ohio.

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A Production-Proved Product of
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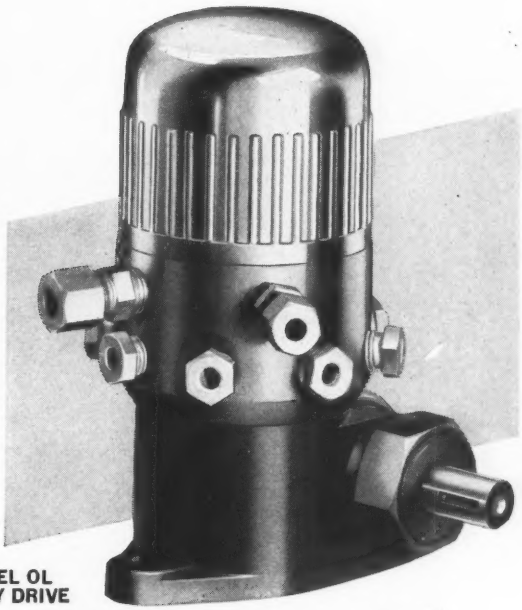
for 85%
OF ALL METAL CUTTING JOBS

PRODUCT

MADISON-KIPP LUBRICATORS

Fresh Oil FED UNDER PRESSURE BY THE MEASURED DROP

The Model OL is the smallest in the series of six MADISON-KIPP lubricators. It is used where space is limited and for built-in applications in separated units of machinery where the most reliable type of lubrication is vital.



MODEL OL
ROTARY DRIVE

PROCESS

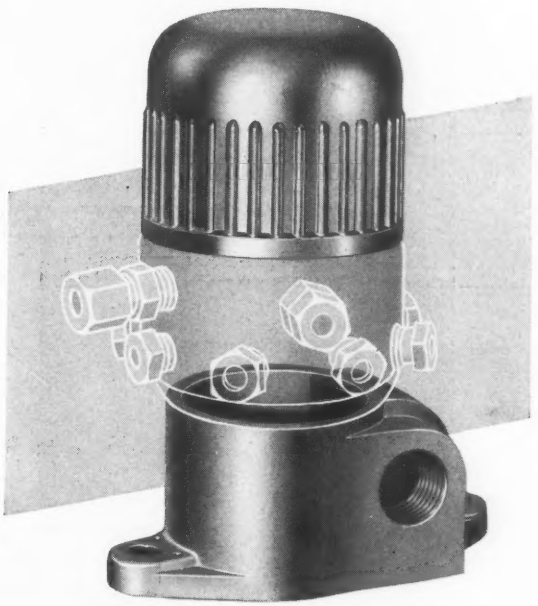
MADISON-KIPP DIE CASTINGS

IN ZINC AND ALUMINUM

Die castings as illustrated provide two important functions in the OL lubricator. They combine economical basic parts with pleasing appearance.

When you are designing new products, do not overlook the advantages of the die casting process.

Please send all your inquiries to the home office in Madison, Wisconsin.



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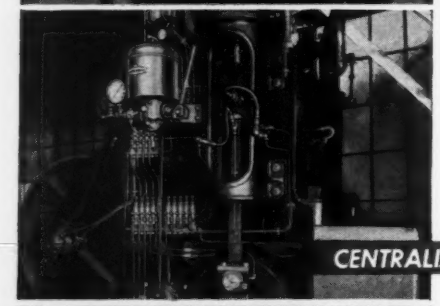
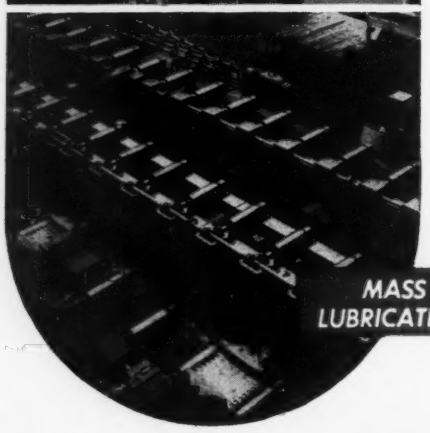
NOW IS THE TIME TO BEAR DOWN ON PRODUCTION COSTS

Lubrication Practices Must be Standardized as a First Essential . .





Mass Industry must of necessity standardize all operating practices for maximum efficiency in the use of labor, and materials if the utmost in plant economy is to be realized.

Lubrication practices must be standardized like all other plant operations.

You can organize your lubrication practices by *standardizing* with Lincoln Lubricating Equipment. This proven line offers you a selection from a wide range of complete systems, for the periodic manual application of lubricant, or for fully automatic, time-controlled, powerized systems designed to dispense measured quantities of lubricant at predetermined time intervals.

Call your Lincoln Distributor or the Sales and Service Office nearest you for expert recommendation on *standardizing* your lubrication practices. Ask for bulletins on Lincoln Centro-Matic Systems and Industrial Catalog No. 63.

- APPLY THE RIGHT LUBRICANT
- IN THE RIGHT QUANTITY
- AT THE RIGHT TIME

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ROLL NECK BEARINGS

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Rolling Mills - Wire Mills - Gas Producer Machines - Regenerative Furnace Control

The action of an oil film under pressure between two highly polished bearing surfaces is governed by well-known hydro-dynamic principles. MORGOIL Bearing design is based upon these facts and full advantage has been taken of the tremendous load-carrying ability of a film of oil.

While scientific lubrication is important it must be coupled with correct bearing design to achieve MORGOIL results.

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WORCESTER, MASSACHUSETTS

English Representative International Construction Co.
56 Kingsway, London, W. C. 2, England

LE-3

He's a particularly vicious thief. He preys on machines in plants of all kinds all over the country—slowing production, slashing profits, collecting an enormous toll from industry.

You think he's not at work in *your* plant? It will pay you to be suspicious enough to find out *for sure*—for his ways are devious.

For example . . . here are some places to look.

Are the grease guns in your plant still being filled by old-time "paddle" methods—wasting time, wasting grease, risking contamination and dirt? You've caught a suspect!

You can save 3¾ man hours for every 100 lbs of grease and eliminate contamination risks.

Are you lubricating machines by "hand and muscle"—the old, time-wasting, hit-or-miss method? Here's evidence of thievery!

You can save as much as 23.9 man hours in applying each 100 lbs. of grease!

What about the cost of "down-time"—when a bearing burns, a gear fails, precision is "off" because of faulty or inadequate lubrication? Thievery again!

You can eliminate human error—make sure that each lubrication point gets the correct grease, in an accurately measured amount and at the proper time.

Have you any suspicions that there is a profit thief loose in your plant? Is he hiding behind the mask of faulty, old-time, costly lubrication methods—robbing you just as surely as though he "tapped the till"?

There's one proven way to stop this loss.

An Alemite representative can tell you in 10 minutes how Alemite Methods will simplify and better organize your lubrication procedures. He can show you how mechanized lubrication from barrel-to-bearing will increase your production and profits.

Telephone your Alemite Distributor. Or write to Alemite, 1847 Diversey Parkway, Chicago 14, Illinois.

ALEMITE

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MODERN LUBRICATION METHODS THAT CUT PRODUCTION COSTS

Another Product of STEWART WARNER

THE EDITOR'S PAGE

Your editor is pleased this month to be able to include a few remarks on lubrication from one of our Directors, L. A. Danse of the General Motors Corporation. Mr. Danse is noted for his ability of saying the right thing at the right time, and these few paragraphs illustrate the point.

"That—*oil is cheaper than machinery*—was stated nearly a half century ago by an industrial executive who later became one of that select group of industrialists called tycoons. His outstanding success was due to his clear perception of the fundamentals of the problems with which he was confronted. The underlying fundamental in this instance is the maintaining of industrial equipment in effective operating condition: the basis of preventive maintenance.

Nowhere is the old saying that *an ounce of prophylaxis is worth a pound of therapeutics* truer or more applicable than in operating a producing industry. Wherever machinery moves, the necessity for lubrication exists. This is fundamental. And wherever men are concerned with keeping machinery moving, there is the need for more knowledge about lubrication. This, also, is fundamental.

Which brings us to the basic idea and purpose of the American Society of Lubrication Engineers—to provide these fundamentals; to fill the need as a source for the information which is primary to all other maintenance knowledge.

Once a machine is constructed and placed in operation, it must be maintained. The cheapest, surest way to maintain it is by keeping it in order and not by the method of letting it break down and then fixing it. The first and most important item of his plan of operation is to provide proper lubrication for the moving parts. If this is not done, everything else suffers, and sometimes production is lost.

A.S.L.E. enters the picture here in undertaking its most important function of gathering, sifting and distributing knowledge of lubrication through interchange of ideas between members, through publications and papers presented at meetings.

The importance of lubrication to management was also exemplified by the paper presented at the recent Convention in New York by Granville M. Read, Chief Engineer of E. I. du Pont de Nemours and Company, entitled "What Lubrication Means to Management." With management behind lubrication we are encouraged to dig in and improve our knowledge of lubrication. Nowhere else can this be done so well as through participation in A.S.L.E. activities."

Lubrication leads to economy in machine operation and production. Economy at another level in this country seems to be an unhealthy state. Our Democratic administration looks back with great pride to the founder and sponsor of the Democratic party—Thomas Jefferson. To analyze how well our present leaders follow his precepts it is of interest to refer to a quotation from Jefferson's writings which an historian recently unearthed:

"I place economy among the first and most important virtues, and public debt as the greatest of dangers to be feared. To preserve our independence, we must not let our rulers load us with perpetual debt. We must make our choice between economy and liberty, or profusion and servitude. If we run into such debts, we must be taxed in our meat and drink, in our necessities and in our comforts, in our labors and in our amusements. If we can prevent the government from wasting the labors of the people under the pretense of caring for them, then they will be happy. The same prudence which in private life would forbid our paying our money for unexplained projects, forbids it in the disposition of public money."

Would that our leaders, both Democratic and Republican, might look to the counsel of a wise man! In truth, the rate at which this country's wealth is being dissipated should cause each of us so much concern that we, personally, should take steps to influence the actions of Congress. As individuals, there is little we can do except convince our leaders that economy in Government is politically popular. The National Chamber of Commerce published a list of things that each one could do to help in this regard. The suggestions should be followed, whenever possible:

1. Familiarize yourself with as many facts as possible on specific subjects relating to government spending, so that you will be on sure ground and better able to express a well-informed, well-reasoned point of view on the subject.

2. Use every opportunity that comes your way to help inform others about federal finances and the present tax burden—through meetings, radio programs, speeches, letters, personal conversations.

3. Refrain from asking for federal funds for local or state public works projects that are not of immediate necessity—or that are merely of local benefit and not of national interest.

4. Avoid lending your influence to movements to initiate new forms of government spending.

5. Interest your local and state chambers of commerce in popularizing the need for economy in government.

6. See that your civic clubs, veterans' groups and other organizations are fully informed about spending and show them what they can do to help keep government expenditures down.

7. Actively urge your Senators and Representatives to economize on specific measures. Support them in their over-all efforts to cut the federal budget, and let them know that you approve of their efforts.

8. Wherever you are, make yourself a center of influence to help in the fight against waste in government and to help make economy in government politically popular.

LUBRICATION OF RAILWAY ROLLING STOCK*

by William M. Barr
Research & Standards Consultant
Union Pacific Railroad Company

Dr. Barr obtained his Bachelor of Science Degree at Iowa University. He then attended Grinnell College for his M. A. and the University of Pennsylvania for his Ph. D.

He taught chemistry in Grinnell College and held a Professorship at Iowa State College in charge of Engineering Chemistry and Metallurgy.

Dr. Barr became associated with the Union Pacific Railroad in May, 1916, as Consulting Chemist, then advancing to Chief Chemical and Metallurgical Engineer, his present title being Research & Standards Consultant. The department which he heads has charge of all water supply problems, inspection of all materials and new equipment; makes studies of material failures and is responsible for quality of lubricants; control of Chemical and Physical Laboratories, including two established for the control of lubrication and fuels in diesel engines.

He has been active in the American Society for Testing Materials and was President of this organization 1940-41; is a member of the American Chemical Society, American Institute Chemical Engineers, American Society for Metals, American Welding Society, American Railway Engineering Association, Sigma Xi and others.

In presenting this subject it is not intended to offer solutions for the various problems that arise in lubrication or even to recommend practices to be followed, but rather to recite the experiences encountered during many years and in presenting the problems involved, hope that this will develop discussion and possibly bring out the answer to some of these problems by the members of this organization. There are so many things that we do not know about lubrication that a research friend suggested that I talk about the things we should know, but don't.

Until recently practically all railroad cars were equipped with friction bearings and these were lubricated by being packed with waste saturated with oil. There is a wide difference of opinion as to the character of waste which is best to be used. It has been common practice in freight cars to use a cheap cotton waste. The AAR has fixed a standard for this product. This waste should be as free from lint as possible and should be a long strand waste to avoid short fibers and lint working under the bearing, thus shutting off lubrication, causing dry friction which naturally results in heating of the bearing.

For many years nearly all railroads used two grades of oil to meet seasonal temperature changes and there was little regard for the type of oil, whether it be of napthenic or paraffinic base. It was especially desirable in periods of low temperature to have an oil with a low pour point and with the older oils used, a large percentage was napthenic base without much regard to the tarry matter contained in the oil. Such an oil in zero or sub-zero temperatures would thicken long before it reached the pour point. This had a tendency to roll the packing and actually push the waste out of the boxes.

It was found that if limits were placed on the insoluble and tarry matter and an oil contained a high percentage of paraffin base, the oil would not thicken to the same degree as the napthene base oil and therefore would not roll the packing. Even though the oil became solid, as soon as the journal began to move, enough temperature was produced to liquefy the oil and a much improved performance was obtained.

Increasing speed in both freight and passenger cars, together with increased weight on journals, made this problem more difficult. More and more weight was added to heavy passenger cars by applying air conditioning and other devices to existing equipment until some of our passenger cars are now as heavy as 93 tons. Speed has been greatly increased to meet new passenger schedules and where the outside temperatures are high (100 and over), the limit of the friction bearing is approached. Therefore, unless the truck assembly, including boxes, bearings and journals, is in perfect condition, hot boxes are likely to develop. A friend of mine recently made calculations on loads, speeds and desert temperatures, and stated that theoretically the bearings on heavy passenger cars should not run at all. As a matter of fact, they are like the bumble bee that cannot fly according to the theory of aeronautics.

Such conditions, however, hastened the development of the roller bearing for railway equipment. This appears to be the answer to the problem of lubricating passenger cars.

Many of the roads are getting away from two grades of oil for summer and winter service and all weather car oils have been developed that are quite successful. However, there still are many carmen who insist that heavier oil is necessary for hot weather service. Obviously the lighter oil shows better capillarity in the waste, but the film strength of such an oil is much below that of the heavier summer car oil. It appears from this that added film strength to the lighter oil will give better lubrication than heavier oil without an additive. Therefore, there is some tendency toward the addition of an extreme pressure compound to car oil in order to maintain a viscosity that will give better capillarity and free feeding of the oil to the bearing. It is the judgment of the writer that this trend should be developed, both for passenger and freight car lubrication.

The lubrication of roller bearings is a fairly simple matter as any good lubricating oil that is clean and does

* Paper presented at 4th Annual Convention of A.S.L.E., New York City, April 12, 1949.

not become solid at low temperatures will readily lubricate roller bearings if oil is kept in the boxes. This requires frequent inspection and servicing as roller bearing boxes have not yet been developed that do not permit the loss of some oil through the space in the back of the bearing. The most common practice is to use a fair quality of oil with a reasonably low pour point which has a viscosity at 210F of 65 to 70 seconds. Some recommend an oil having a viscosity as low as 50 seconds at 210F, but this is likely to result in a greater loss of oil and is not generally recommended. Some are still using a much heavier oil having a viscosity as high as 140 seconds, but most oils of this viscosity will have a high pour point (25 to 30F) and if a car with this oil is standing in sub-zero temperatures, the oil will not flow behind the rollers and this is likely to increase the wear by lack of lubrication until the box reaches a temperature above the pour point of the oil. Therefore, the most desirable oil appears to be the one having a viscosity of 60 to 70 seconds at 210F with a zero pour point.

The use of grease in roller bearings on cars is now being given serious consideration. The only advantage offered by the grease is reduction in the amount of servicing required. Opposed to this is the high price of grease compared to oil. Oil being a common standard lubricant and fairly uniform in physical properties, it is much simpler to use oil in cars in interchange than to use grease. Either furnishes good lubrication and there is less loss of lubricant from grease lubricated bearings than where oil is used. It, therefore, seems that the choice between the two lubricants is purely a matter of economy and this has not yet been fully determined.

Where cars are not subject to interchange, inspection and control of the lubrication is not difficult and a period between inspection and the addition of lubricant can be quite closely fixed with safety. For economy with grease lubrication, it is desirable to have roller bearing boxes so designed that the volume of grease required is much less than is commonly used in the oil lubricated roller bearings. Practically all of the roller bearing boxes in passenger equipment have been designed for oil and it is therefore probable that the use of grease in such bearings would be less economical than oil. The design of roller bearings now in use in freight service is such that grease may prove economical. Service tests are now being run to determine the relative economy. The subject of interchange of freight cars with grease lubrication is now being considered. Manufacturers of roller bearings are not all agreed on the correct physical properties for grease lubrication. If roller bearing boxes are constructed with a minimum of clearance in the back of the box, there should be no difficulty in selecting a grease that will be sufficiently light to flow into the races and not be heavy enough to result in channeling when cold, and at the same time avoid loss of lubricant by throwing the grease out of the box.

It is much more difficult to make a specification or fix a standard for roller bearing grease than for oil and because of the longer time between servicing, there may be some danger of freight car bearings losing lubrication to the point of heating. This subject is still an open one and definite conclusions cannot be drawn until more extensive studies have been completed.

The lubrication of steam power calls for limited comment. In the early days when locomotives operated at 150 lbs. pressure with low superheat, or none at all, the lubrication of valves and cylinders was not difficult. At the present time, practically all steam power is superheated and steam temperatures run to 750F and higher.

It is generally accepted that valve oil should be the highest quality of high temperature paraffin base oil, most of which is made from Pennsylvania stock. Compounded oil containing acidless tallow or prime lard oil has been in general use. However, a number of roads are now operating with a straight mineral oil. The only object in using compound is to improve the adhesion of the oil to wet, polished steel surfaces. With superheated engines, this condition occurs after the engine has been standing, permitting condensation, or in case of carryover. With the extremely high temperature of the steam entering the valves and cylinders, the organic fat may be decomposed and may result in more insoluble deposits on valve and cylinder rings and grooves than would occur with straight mineral oil. This condition is likely to more than offset the advantage of the compounded oil for lubrication of wet surfaces.

A number of roads are now using a straight mineral oil successfully and so far as known, no accurate figures have been obtained which show more wear on rings and cylinder walls than occurs when using a compounded oil. The accumulation of carbon deposits which result in stuck and broken rings has always been a difficult problem. Cleaning is difficult and expensive and the suggestion has been made that a compound may be used in valve oil similar in character to that added to diesel engine oils to keep rings and grooves free from carbon. This offers a field of research for the lubrication engineer and the refiners.

The method of lubricating driving journals and rods has not been changed for many years and the selection of a grease for this type of lubrication depends upon the size of the engine and the character of the service. Therefore, different roads will use greases of different physical properties successfully.

Some work has been done with engines equipped for oil lubrication. Various designs have been brought out for this purpose and it is reported that satisfactory lubrication is being obtained on some roads with oil lubrication, especially on driving journals. This also offers an opportunity for further study since it is a general principle that best lubrication is obtained whenever the proper quality of oil can be successfully fed to the journal and bearing.

In the lubrication of motion work parts, it has been the general practice to use a cheap, simply made grease of a consistency that will feed readily to the motion work. This method has been wasteful and the ordinary grease readily runs off the part to be lubricated, or is washed off when engines are cleaned. Greases have been developed which have a tackiness sufficient to improve the adhesion of the grease to the moving part and in some cases lead compounds have been added to this type of grease which have improved the lubrication and reduced wear. A great deal of work has been done in the development of new greases with definite improvement, with the possibility of still further advantageous development.

The lubrication of diesel engines is extremely important. Practically all lubricated parts being precision equipment, they must be properly lubricated and the life of the engine is largely dependent upon the quality of lubrication.

The use of high grade paraffin oils without an additive builds carbon deposits rapidly in ring grooves, on valve stems and cylinder walls with a result that with such a lubricant there will be many stuck and broken rings and excessive cylinder wear and sticking valves. The first diesel engines used in railroad service were low speed engines without excessively heavy loads on the cylinders. In such engines a highly refined pure nap-

thenic oil gave good results, kept rings and cylinders clean and rings were free. As speeds were increased and more horsepower per cylinder was developed, it became necessary to have an oil of greater strength, requiring the addition of some high grade paraffin base oil. With such an oil, or with pure paraffin base oil, it is necessary to use additives to properly protect the engine parts. The two principle additives are a detergent or dispersant and an anti-oxidant compound. There is usually a third additive to prevent frothing or foaming of the oil. Such additives keep the carbon in a finely divided state and prevent it building up in ring grooves, on valve stems and pistons, and prevent corrosion due to oxidation of the oil at the high temperatures of the cylinders.

A difference of opinion exists among refiners as to the character of base oil necessary for proper service. Some use oils having a high viscosity index which are essentially pure paraffin base products, others use mixed base oils having a viscosity index of from 30 to 60. With proper additives and properly refined oils, both types have performed successfully. The experience of the writer has been largely with mixed base oils and good results have been obtained with oils having a viscosity index of 35 to 45, also with oils having a viscosity index of 55 to 60. Service tests have been made with both types of oils in which no measurable wear has appeared after more than 100,000 miles of service.

In order to obtain correct lubrication, a considerable responsibility rests with the engine builder. It is absolutely necessary that the engine be equipped with filters and that these filters are large enough and so arranged that a fairly large percentage of the oil will pass through the filter in order to keep it clean and avoid scoring of bearings from hard particles embedding themselves in the surface of the anti-friction metal in the bearing. It is equally important that sufficient oil pressure be maintained to thoroughly circulate the oil and avoid excessive temperatures, at the same time having sufficient pressure to force the oil between the bearing and the shaft. In some engines oil pressure has dropped very low when the engine is idling and bearings have shown evidence of being starved for lubrication.

During idling periods, with low oil pressures, there is also a tendency to dilution of the oil and this may become so thin that it does not have the necessary film strength or lubricating qualities to properly protect the bearing parts. There is no oil of high enough quality to give proper lubrication to a diesel engine unless the oil is properly filtered and sufficient oil pressure maintained at all times.

There has recently been a great deal of discussion with differences of opinion expressed on the desirability of mixing oils in diesel power. It is impossible for anyone to say that two oils can or cannot be mixed successfully. Only after long service tests and careful observation can this question be decided. The refiners do not divulge the composition or combinations in the additives used. For this reason, the consumer is necessarily puzzled. We know there is a difference in the additives used by the different refiners. The amount and character of the additive required has not yet been fully determined. The character of the base oil also affects this selection of additive. One base oil may operate successfully with a certain combination of additives and a definite proportion of these additives put into the oil. A refiner using a base oil of different character may require a larger or smaller percentage of additives and the proportion of detergent and deoxidant may vary. Accordingly, in mixing two or more additive oils, a different result may be obtained from that found when the oils are kept separate. Cases have been reported where mixed additive oils have been used with poorer results than was obtained with any one of the oils used separately. Therefore, it is the opinion of the writer that it is better to keep on the safe side and keep these compounded oils separate.

Our friend C. F. Kettering has very aptly said that the engine itself knows better what it wants than we do. As far as can be seen, the proper oil to use in a diesel engine is one that keeps the rings free, valve stems and pistons clean and shows the least wear.

The reclamation of diesel engine oil is a general practice, but there is considerable difference in the quality of the oil reclaimed by the different processes now in use. If the reclamation process is thorough, the quality of the reclaimed oil should be comparable to the new oil and in reclaiming additive oils, the additive should be restored by thoroughly mixing the correct proportion with the hot reclaimed oil. This practice has been followed successfully and too much emphasis cannot be laid upon the quality of the oil so produced.

There has recently been some agitation directed toward the writing of a specification for oils for diesel engine service. This does not appear to be desirable and it is questionable as to whether or not it is possible. No specification should be written without complete knowledge of all of the materials contained in the product specified. If this is done, all initiative of the refiner to produce a better oil than his competitor is destroyed and the placing of responsibility for performance is cancelled. Such a specification would be extremely difficult and laborious to check and assure the consumer that the oil purchased fully meets the specification. For these reasons, it is the opinion of the writer that the development of a specification for diesel engine oil should be discouraged.

There are a number of lubricants used in diesel locomotives other than that used in the crankcase of the engine. These should be given careful attention. In some cases the engine builder has recommended lubricants for some of the accessories that have not proven entirely satisfactory. An example is the use of diesel engine oil in air compressors. Engine oil is not an air compressor oil and the service has shown that a different type oil, which we term "air compressor oil" and which is approved by the air compressor companies, has given much better results than the use of engine oil.

Another case is that of the engine governors. The governor on one make of engine may require a good quality of SAE 10 paraffin base oil. Another governor will not operate satisfactorily with this oil, but requires an SAE 30 of the same quality.

The lubrication of traction motor roller bearings has been successful with certain types of grease. The same bearing may be successfully lubricated with another grease, but the two cannot be put together in the same bearing and operate successfully because the greases are not miscible. On the other hand, several satisfactory greases have been made that are miscible and give satisfactory results when two or more of the greases are in the same bearing. Other traction motors have now been furnished with bearings built for oil lubrication and operate satisfactorily.

It therefore appears that it is necessary for the Lubrication Engineer to make careful study of the various lubricants and fit them to the particular piece of equipment at hand.

Another point in the diesel power unit that is deserving of attention is the proper lubrication of driving gears. There is no part in these locomotives that takes a more

severe load than the pinion and ring gears that drive the locomotive. The present practice of lubricating driving gears appears to be somewhat crude. In order to make the lubricant adhere, the manufacturer has used a heavy asphaltic product in large proportion with a small amount of real lubricant. When cold, this puts a very heavy drag on the gears. It appears to the writer that research should be conducted toward developing a gear lubricant that will have a higher lubricating value and at the same time stay where it is effective. In this line, some study might be given by the engine builder toward designing a gear case that will better prevent throwing the lubricant out of the enclosure.

Another important point for lubrication is the motor support bearings. These bearings are operated on the principle of the waste packed bearing, but in order to have the oil reach the journal, it is necessary to use long, high quality wool yarn which will at all times have good capillarity and maintain a constant flow of oil to the journal. The recently developed felt pad lubrication on the same principle has also been successful. It has been generally believed that an ordinary car oil of proper viscosity will satisfactorily fill these requirements. However, it must be admitted that the cleaner and higher the quality of the oil, the better will be the capillarity and the film strength and it should be reasonable to assume that such an oil will give better lubrication for a longer period than the cheaper oil. The writer experienced some difficulty on certain engines that were in unusually severe service. The application of the best quality of yarn and high grade oil, such as an oil similar to an SAE 30 motor oil resulted in notably better operation.

It has been the object of the writer in this paper to present problems of lubrication of railway rolling stock as found in his experience, admitting that there are many things that years of experience and study have not answered, but this has been done with the hope and belief that there will be considerable discussion from the floor which may be of much help to those of us who are confronted with the operation of railway equipment.

Discussion by B. D. Jennings

Chief Chemist, The New York, New Haven and Hartford R. R. Co.

In line with Dr. Barr's paper on lubrication of rolling stock and with particular reference to car journal oil and its tendency to cause rolling of waste in cold weather, the thought occurs to me that we should give more attention to the viscosity of O F; this, of course, with the understanding that the oil selected possesses sufficient body for proper lubrication under operation conditions.

This thought is based upon the fact that some years ago I experienced severe rolling of car journal waste in cold weather with an oil possessing viscosity at 100 F of 660 seconds, at 210 F of 65 seconds and at 0 F of 200,000 seconds; while with an oil possessing viscosity at 100 F of 609 seconds, at 210 F of 70 seconds and at 0 of 80,000 seconds there was no rolling experienced.

Discussion by J. J. Laudig

Research Engineer, Delaware, Lackawanna & Western R. R. Co.

The field of Railroad lubrication has been well described by Dr. Barr, and he leaves the Railroad Lubrication Engineer some very important problems.

I would like to comment briefly on one part of Mr. Barr's paper which I feel is most important, namely Car Journal Oil.

Although passenger car bearings seem to be predominantly roller bearing, the vast number of friction bearings in freight service, and the changing tempo of the service makes imperative an improvement in the lubricants used.

There are a number of car oils now under test which have been developed along lines suggested by Dr. Barr, i. e., better refined light oils with film strength additives. It is hoped that data and possibly a paper on this important subject will be available for the Society in the near future.

I am interested in one item on Diesel Lubrication mentioned by Dr. Barr, namely difficulties experienced when idling, "Bearings having shown evidence of being starved for lubrication."

May I ask what bearings showed difficulty and what minimum oil pressure was found necessary to overcome this trouble.

Discussion by R. W. Seniff

Engineer of Tests, Baltimore & Ohio Railroad

Dr. Barr is to be congratulated for his treatment of this subject. Certainly no one is better qualified in this field. Few, if any, could have better summarized the status of the present knowledge.

His opinion that the trend in railroad car lubrication should be in the direction of one grade of oil, possibly with a film strength additive, deserves serious consideration. The present practice on many railroads of using a summer and a winter car oil results in many freight cars operating on winter oil in summer and summer oil in winter. The fact that interchange freight cars operate in all parts of the country and may be subject to warm weather one week and bitter cold the next, further complicates the problem. One compromise oil suitable for all climatic conditions is highly desirable.

This discussor agrees with his statements relative to roller bearings on railroad cars. Tightness against oil or grease leakage from the bearing boxes is an important requirement. Roller bearings for freight car axles are desirable but the initial cost is so high that there is reasonable doubt of their economic advantages. If they can be made rugged enough—tight enough that they will run at least a year between lubrications and cheap enough to be economically sound, they may be of greater interest for cars in interchange service.

Dr. Barr's statements concerning lubrication of steam locomotive driving journals aptly illustrates that there is more than one way to meet lubrication requirements. Most railroads use for friction type bearings typical "railroad" greases, which are extremely hard and highly compounded. Some, however, lubricate these bearings in severe service with straight mineral oil delivered to the bearings through the medium of felt pads and pumps activated by the lateral motion of the wheel and axle assemblies. Mileages as high as 250,000 on crown bearings in high speed freight service are not uncommon.

The comments relative to the lubrication of Diesel traction gears are thought provoking and appear to be timely ones.

The importance of good lubrication for the engines of Diesel electric locomotives is well presented. The horse power taken from each cylinder has increased steadily. Each increase placed new demands on the lubricating oil until the capabilities of straight mineral oil were exceeded. A certain amount of controversy still surrounds the discussions concerning straight mineral oils—versus—the compounded oils known as heavy duty type. It is interesting to recall the same kind of controversy surrounded the problem of lubricating hypoid gears when they were first introduced for automobile passenger cars years ago. Today they are all lubricated with compounded oils and no one would think of using a straight mineral oil for that purpose.

The author has raised several important questions concerning crankcase oil for Diesel locomotive engines. They are as follows in what this discussor considers their order of importance:

(1) Can specification be written for such oils?
(2) What is the effect of additive and base stock upon one another?
(3) Can different brand named oils be mixed and used successfully?
(4) What is the effect of reclamation?

The fact that these questions are raised and that there are strong differences of opinion concerning them is ample evidence that we have problems requiring exhaustive investigation. There appear to be several approaches to answering the first one. All are now in use. Correlation of their results should give the answer. These are as follows:

(1) Laboratory screening tests in small engines similating conditions found in their larger counterparts.
(2) Laboratory tests similating certain specific engine conditions such as heat and air effect, or the effect of metals, fuels, water, and water treatment chemicals on oxidation, corrosion, and lacquer deposits. Sufficiently good correlation with actual engine conditions has been observed, to indicate that these tests are an essential

part of any program for investigation of crankcase oils for Diesels.

(3) The study of lubrication of full scale Diesel engines such as those used in locomotives is an essential step. Such a study is probably more difficult than that in any other type of equipment. Initial cost, cost of operation, the running time required for thorough lubricating oil tests and the difficulty of duplicating railroad operating conditions makes stationary testing of full scale engines extremely costly and difficult. Under such conditions, very few oils could be thoroughly tested per test engine per year. Where 300, or at most, 500 hr. tests are made on most laboratory engines, railroads are interested in what happens to the engine in 8000 or more hours of operation. Full scale engines of one or two cylinder are badly needed for this purpose. None are available at this time. They probably will not be made available unless the railroads evidence sufficient interest in this approach to their problems.

(4) The final and real test is on the engines in locomotives which are operating in actual train service. This, too, is a costly, time-consuming process. It is complicated by the fact that the engines are motive, are handled successively by different enginemen, serviced at several fueling stations and are subject to varying operating conditions and maintenance practices. The effect of the fuel oil quality on the lube oil and the effect of the lube on the deposits and blow by gasses from the fuel are inseparably linked and must be taken into consideration. Successful tests have been made under such conditions. Those who have made them, can attest to the cost and difficulties attending the completion of such a test.

It appears that all four of these approaches must be used and correlated with one another—that specifications for lube oil must be based on actual engine requirements—but when these are known, they can be interpreted into more simple test procedures whcih will permit us to aptly describe the characteristics required in an oil for lubricating the engines in question. Performance specifications must be combined with the conventional physical and chemical specifications.

What does the foregoing amount to? Simply this—that we accept as self-evident the statement attributed to Mr. Kettering that—"The engine itself knows better what it wants than we do." Therefore, let the engine write its own specification. Here, as in science in general, we only act as interpreters.

To say that we cannot write a specification means that we cannot understand the engine. A specification based on performance or adequately similated performance does not need to depend on intimate knowledge of all the material contained in the product. Why should we worry about what is in the product as long as it meets satisfactory performance standards, unless we want to reproduce the product. That is the refiner's job—let him worry about it. To say that a user's specification destroys all initiative on the part of a refiner appears to imply that knowledge of our engines' needs retards progress.

On the contrary, this discussor believes that nothing would be more stimulating to initiative and progress at this time than a thorough understanding and a clear-cut statement of the needs of our engines and those of the railroads' purchase, stores, and mechanical departments regarding what is required of lubricating oils for Diesel engines in locomotives.

The effect of additive and base stock upon one another has been a subject of lively discussion. A series of tests run by the discussor indicate that the effect of the additive is far greater than that of the base stock. These tests included a series of napthenic oils of very low V.I., mid-continent solvent refined of 50 to 70 V.I. and some high V.I. oils. This subject is the producers' problem rather than the railroads'.

The mixing of oils is a subject which has taken on the aspects of a comic opera. We do a lot of talking about it and make little effort to develop the facts. Oxidation, lacquer and corrosion tests ran in the discussor's laboratory on a number of oils of different base stocks and containing different additives, indicated surprisingly enough—after all the talk we have heard—that the results were exactly what one should expect—an approximate average of the characteristics of the various oils in the mixture. In no case were the results inferior to those obtained from the poorest oil in the mixture. These results reproduced themselves so monotonously that it would be refreshing to find a combination where the results were poorer than those from the poorest oil in the mixture. It was interesting to note how some poor oils were improved by mixing them with those showing good performance. For the sake of our purchase and stores departments and protection of our mechanical department, it is high time we were finding out just what can be done in this respect. Those who take the extreme rightist viewpoint and say "keep oils separated at all costs," do not appreciate the problems of the purchase and stores people. Those who say "mix indiscriminately" may not be protecting the mechanical department. In the interest of efficiency and economy, we should stay in the middle of the road and with the cooperation of the engine builders and refiners, arrive at some sensible conclusion based on facts instead of fancy.

The effect of reclamation on used crankcase oils has been a subject of much misunderstanding. Dr. Barr is correct when he states that additives must be blended back into reclaimed heavy duty oils. Contrary to the common conception, reclaimed oils with few exceptions lose stability upon reclamation. This applies to straight mineral and heavy duty oils. Refortifying with additive makes straight mineral oils, after reclamation, better than they were when new and unfortified. It brings heavy duty oils back to the practical equivalent of their qualities when new. Practically all new heavy duty oils lose additives rapidly in heavy duty engines—they should not be penalized by mixing unfortified reclaimed oil with them.

Lubrication of Diesel engines in railroad service is a relatively new problem for American railroads. No piece of equipment ever operated by them involved the unit costs or presented such lubricating problems. On the other hand, no piece of railroad equipment ever offered a better opportunity for the lubrication engineer to show what he can do. All he has to do is learn the language of the Diesel engine and interpret it into words and action.

Discussion by P. V. Garin

Engineer of Tests, Southern Pacific R. R. Co.

I have read Dr. Barr's paper with great interest as we have many mutual problems in the lubrication of railway rolling stock and it has been my pleasure to work closely with Dr. Barr on some of these problems. In discussing this paper, I should like to inject comments on the various phases of the subject mentioned based on my own experience and that of my associates.

The lubrication of friction bearings, or plain bearings as they are sometimes referred to, on axle journals has, of course, been of major concern to the railroads. The trend to increase bearing loads and train speeds have accentuated this problem. It is the general inclination to consider all overheated bearings as lubrication failures, usually attributable to the quality of waste and oil used. However, this is not the case as there are many mechanical irregularities that can contribute to or cause overheated bearings even if the best quality of waste and oil is used. In an excellent paper entitled "Lubrication of Railway Equipment Plain Bearings" presented by Mr. L. A. Drucke, Lubrication Engineer, The Texas Company, before Northwest Carmen's Association at St. Paul, Sept. 8, 1937, some sixty (60) mechanical conditions are mentioned that interfere with proper journal lubrication and which can cause or contribute to overheated bearings. Among these are improperly finished or cut journals, hard spots in lining metal, uneven distribution of load, improperly fitted bearings and wedges, truck out of tram, lack of servicing of box, etc.

Railroads should by all means purchase the best quality journal box oil and waste available, but should not complacently feel that these will solve their hot box difficulties as there are many other factors involved in preventing overheated bearings. If these factors are not corrected proper lubrication cannot be secured even with the ideal waste and oil.

Dr. Barr mentions that journal box oils which thicken long before the pour points in cold weather have a tendency to roll the packing and actually push the waste out of the boxes. One thought occurs here which is relative to the amount of water contained in the waste. At temperatures in the zero range, the presence of moisture to any extent in the waste will greatly complicate the problems of lubrication.

Statement is made that there is some tendency toward the addition of an extreme pressure compound to car oil in order to maintain a viscosity that will give better capillarity and free feeding of the oil to the bearing. I believe that this is true if it is taken in the light that most extreme pressure additives are of the nature to give penetrant qualities to the oil. In many instances there seems to be some misconception of the term "extreme pressure." Among the extreme pressure additives to oil there are such as organic sulfides and chlorinated hydrocarbons. Compounds of this type will not alter viscosity-temperature relationships, but will confer the property on the lubricant of penetration into low clearances which could consequently be interpreted as giving better properties of capillarity.

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In regard to grease lubrication of roller bearings, there is no doubt that the proper grease can be selected and the modern technology of greases which incorporate metallic soaps of a greatly varying property should readily secure a grease which would have sufficient tackiness or adhesiveness to prevent channeling even when the temperatures are in the lower range.

The compounding of valve oil for steam locomotives having cylinder steam temperatures of 750° F or higher, including about 350° F of superheat, presents a difficult problem as compared to the compounding of crankcase oil for Diesel locomotives. The diesel engine oil in the crankcase is operating at a much lower temperature than does the superheat valve oil in the steam chests and cylinders. The oil in the crankcase is there as a liquid and in considerable mass, whereas the superheat valve oil is injected into the steam chest and cylinder as a mist and is therefore in very minor amounts. Since, in a steam engine, the oil is continually functioning in an atmosphere of steam, all air is precluded as long as the engine is functioning under proper conditions and oil cannot oxidize. It has been our experience that the chief cause of carbonizing rings and grooves is by improper operation of the engine during drifting. At certain points in the cycle, if the engine is hooked up and working no steam, there will be a vacuum produced in the cylinder which, when the exhaust port opens will allow the entry of hot front end gases. Fine metallic oxide particles are also entrained with the hot front end gases which catalyze the break-down of the oil and it is carbonized very readily, adhering to rings and grooves. Equipping engines with circulating valves or properly employing a drifting throttle affords adequate protection against carbonization of steam valve oils. We have observed many steam locomotives which, having been operated under proper conditions, had steam chest valve rings and grooves as well as cylinder packing grooves in a clean and proper condition, free from accretions of carbon.

The Southern Pacific Company operated many steam locomotives with oil lubricated driving journals with very satisfactory results. Oil is fed to journal boxes by means of a mechanical lubricator and a spring pad lubricator applied under each journal insures constant lubrication.

The proper lubrication of Diesel engines, as stated by Dr. Barr, is of primary importance in the successful operation of this type of motive power. For crankcase oil, the tendency has been for most oil refiners to elevate the viscosity index by the addition of paraffinic stock. The lubrication of Diesel streamliners in the early days was usually accomplished by the use of paraffin base oils which do not incorporate additives. This oil was not adequate for the job and gave a great deal of trouble from the formation of hard, flint-like carbon. Later, oils were developed which were chiefly of naphthenic stock. These oils had a high degree of detergency and reduced carbon deposits on the rings and piston as the oils had a high dispersent effect on carbon. However, they were of very low viscosity index. In fact, some of them had a viscosity index in the region of O, while others were somewhat higher. As is natural with oils of such low viscosity index, the viscosity-temperature relationships were somewhat undesirable and at low temperature viscosity of the oil was so greatly elevated as to prevent proper flow and function. It is a moot point whether the addition of the paraffinic stock was made to increase the film strength or whether it was done to place the viscosity-temperature relationship in a more desirable range.

The use of additive type lubricating oils for Diesel locomotives has introduced the problem of compatibility of one such oil with another, as Dr. Barr points out. On a large railroad system where locomotives are transferred seasonally between districts using diffrent brands of additive type crankcase oil, it is very desirable that the oils be compatible to avoid the draining of one oil and refilling with the other.

It is quite true that the use of additives is more or less in a fluid state of knowledge. Many of the refiners have used additives which have been unsuccessful and there will, no doubt, be some passage of time before our knowledge of the subject has become sufficiently crystallized to select the additive that will confer the beneficial properties desired without any detrimental factors. Knowing the nature of the additives, one may readily understand why two different oils might not be compatible. It is natural that the character of the base oil affects the selection of additives, particularly as to the detergent or dispersent factors. Since naphthenic oils have a high detergency factor, whereas paraffinic oils have a very poor detergency factor, I believe that, as Dr. Barr says, it is better to keep on the safe side and keep compounded oils separate unless one appreciates the nature of the additives used. However, I feel sufficient information is available for one to predicate which additive oils may be mixed without disadvantageous results. In any event, oil suppliers must realize the necesity for furnishing compatible oils of the additive type so that railroads can transfer Diesel locomotives on temporary assignments without the expense of draining crankcases to avoid mixing of various brands of oil that may be used at different terminals.

While there are many complications involved in writing a specification for Diesel lubricating oil, as Dr. Barr states, there is a need for some type of coordination among the suppliers to insure performance requirements and compatibility of the various oils furnished for this purpose. Thus, a specification could be drawn up which would define or specify certain performance features for the oil, which would, of course, be contingent on the nature of the additives employed. This could readily be done in the line of anti-oxidant additives, detergent additives, anti-foam additives and extreme pressure additives. The psysical results would actually define the properties of the oil, place them on a minimum acceptable basis which would in no way destroy the initiative of the supplier to produce a better oil than his competitors.

Dr. Barr states that Diesel engine oil is not entirely satisfactory in air compressors. This is quite true. The type of oil designated as "air compressor oil," is very efficient for compressor service due to the fact that it forms a very soft fluffy carbon which does not adhere to the valves. Oils which form hard, flint-like carbon, give a great deal of trouble in air compressors since such attaches itself very densely on the exhaust valves. If the exhaust valves do not seat properly, wire drawing of the air leaking back through the valves frequently causes sufficient temperature elevation to render the carbon incandescent. In such case, under proper conditions, explosion in a compressor system may occur.

Reference is made to the requirements of different engine governors. This is true since governors of different design and manufacture operate on variant principles and clearances and require oils of different viscosity characteristics.

The lubrication of driving gears in indeed a very important consideration and as Dr. Barr states, there is no part in locomotives that takes a more severe load than the pinions and ring gears that drive the locomotive. It is true, as he points out, that the present practice of lubricating driving gears appears to be somewhat crude. The present heavy asphaltic lubricants, when cold, will sometimes absorb the full power of the prime movers of the unit. It has seemed to me that the necessary tackiness could be secured by employment of some of the specialized soap compounds that are now used in manufacturing greases. Many of these metallic soaps have unique and peculiar properties, such as barium soaps, which give very great tackiness and adhesion and in my opinion could be employed in greases without greatly varying the fluid properties with temperature changes. The oil stock employed in conjunction with the grease could be sufficiently balanced to give enough strength to separate the pinion and gear contacts under the heaviest conditions of loading. The present greases absorb so much power in fluid shear that an immense amount of heat is developed which rapidly thins the grease to a point where its strength is barely adequate to furnish lubrication at the temperatures which are engendered It is also interesting, as Dr. Barr states, to think that there are methods of designing a gear case which will prevent throwing the lubricant out of the enclosure and to carry the thought further and predicate that at some time it may be possible to employ oil or some of the modern synthetic lubricants which will have more desirable characteristics.

Discussion by Ray McBrian

Engineer of Standards & Research,
Denver & Rio Grande Western Railroad

Dr. Barr, in his excellent paper, recites the problems encountered in his years of experience of handling railroad lubrication problems. His paper carries with it a challenge to those whose duty it will be to be concerned with the ever increasing problems related to Diesel and higher speeds of operating equipment in the railroad field.

As I interpret Dr. Barr's challenge it means that it will be necessary to have a "basic understanding of railroad lubrication problems and some means, by which they may be properly evaluated and used to secure proper operating conditions." These we have not had in the past, and I fully concur in Dr. Barr's bringing out the need for discussion of these problems.

Dr. Barr recites the experiences encountered in the lubrication of railroad passenger and freight cars, and he believes that the trend towards the improvement of these "car oils" by adding an extreme pressure additive should be continued. This we fully concur in. Dr. Barr most ably discusses the prob-

lem of roller bearing lubrication and poses the question that further understanding and tests are necessary before full standards can be specified. He has fully discussed the problem of the lubrication of railroad steam locomotive power; i. e., the use of valve oils, driving journal greases and the lubrication of motion parts. We agree that those who will continue to utilize steam power, further advantageous developments in greases and valve oils can be made.

Dr. Barr has fully discussed the lubrication of Diesel engines using additive type oils and has raised some very interesting points. I agree with his statement that the life of the Diesel engine is largely dependent upon the quality of lubrication.

Dr. Barr states that it is impossible for anyone to say that two oils can or cannot be mixed successfully and that only after long service tests and careful observation can this question be decided. This I do not agree with because of our experience after seven years of Diesel operation and analyses and study of regular samples of Diesel crankcase oils. We have found that if specific and regular analyses are made of used oil from each crankcase and of new unused oils before application, and if these analyses are properly interpreted for metal contamination or pick up, rates of wear, corrosion, etc., can quickly be determined, and the quality of an oil or of mixed oils insofar as its effect on Diesel engine parts can be determined in the first few thousand miles of operation and predictions made as to what can be expected by long continued use. Therefore, we have found that any specific oil or any mixture of oils to operate satisfactorily in a railroad Diesel locomotive must have a very low rate of metal pick up in the first few thousand miles of operation and cannot increase at any mileage thereafter. That is, a satisfactory oil or mixtures of oil must not have any greater metal contamination after 100,000 or 200,000 miles of operation than it had at 5,000 miles.

We feel that an understanding of engine crankcase chemistry through study of specific engines under various operating conditions will make it possible for the refiner, the engine builders, and the railroads to have a basis for an understanding in the making of an acceptance or specification test for Diesel lubricating oils. I cannot agree that it is not desirable nor posible to prepare satisfactory requirements. Through the studies made to date of Diesel engine crankcase chemistry under various operating conditions of the years, some important basic facts have been found and these, when understood, can be utilized by the refiner and engine builder without any harmful effect on initiative or the desire to produce a better oil. What I do say is that it is a lack of basic knowledge and understanding as to what is occurring in a Diesel crankcase in actual service and under varying conditions that has resulted in the wide variances and differences in the different range of oils and additives that are being used.

Dr. Barr's views on the reclamation of Diesel oils emphasize the need for proper reclaiming and adding of additive, and if this is done correctly and analyzed properly, reclaimed oils will be comparable to new oils.

The lubrication of other than Diesel engine parts is most ably discussed, and as Dr. Barr states, it is necessary for a lubrication engineer to study his conditions and select the proper lubricants.

May I again say that Dr. Barr in his excellent paper has given us a challenge to accept in really studying and understanding railroad lubrication problems.

Discussion by N. J. Gothard

Sinclair Refining Co.

Dr. Barr is to be congratulated for his paper, presenting, as it does, a compact survey of the field of railway lubrication. As Dr. Barr has said, he has not offered solutions for all the questions, but he has given us a broad picture of the problems faced by the railways. It is not the purpose of this discussion, either, to offer solutions for these problems, but I should like to discuss a few of the points made by Dr. Barr.

In discussing lubrication of cars with friction bearings, Dr. Barr mentioned the increasing speeds and loads of freight and passenger cars, so that the limits of lubrication are being approached, particularly when high summer temperatures and low pour and viscosity requirements for winter are considered. Considerable work is being done with the use of E.P. additives so that a comparatively light all year oil can be used. It would appear that this should be a profitable field for further investigation. Where cars are subject to interchange, a considerable problem of servicing is presented but this could be worked out.

Dr. Barr has mentioned grease lubrication of roller bearings and this is a problem which is being actively studied. It would be highly desirable if all makes of bearings could be lubricated by greases of one consistency, since obviously the economy of operation would be impaired if two or more grades of grease were required, with the accompanying necessity for careful supervision to see that the right grade was applied to the right bearing.

If the expected long periods between servicing are to be realized, it is obvious that a high quality of grease should be used. The mineral oil used in the grease should be of a highly refined type and the soap base should be made using some of the newer developments in fatty oils so that the greases will be resistant to oxidation for long periods of time. The use of an antioxidant additive for the grease should be given careful consideration.

Dr. Barr has discussed the lubrication of valves and cylinders, originally operating at low pressures and little or no superheat, but now operating at higher and higher degrees of superheat. We are in agreement with him that these high degrees of superheat, with temperatures running to 750 F., may lead to decomposition of fats used in compounding with formation of carbon and insoluble deposits and that the use of high quality straight mineral oil is coming more and more to the fore. Some of the larger railroads are using straight mineral oils and have found them to be satisfactory.

The subject of lubrication of diesel locomotives, in all of its parts, is, of course, quite complicated, but of greatest importance. I think it may be said that the engines of today are being successfully lubricated by the use of additive types of oils. However, the engine builders are constantly endeavoring to develop newer engines of higher horsepower and this entails a heavier load on the lubricating oil. Certainly, improved engines are going to be developed and the lubricants will be developed to keep pace with them. This involves a threefold responsibility on the engine manufacturers, the oil companies and the railroads and the closest cooperation should be given by all three in order to keep pace with developments.

Dr. Barr has mentioned the question of mixing of various diesel lubricating oils. This is more than a question of mere compatibility in mixing. It is a question of whether such mixed oils will actually work in an engine. We should like to emphasize that this can be best decided only by actual tests in a locomotive on the road regardless of laboratory findings. We know that different base oils are used and that different additives are used. We also know that additives which are used in one base oil may not work with another base oil or that different proportions may be required. Also, of course, when various oils are mixed and used, no one supplier can be expected to assume the responsibility if such a mixture fails to work satisfactorily. Therefore, I agree with Dr. Barr that the use of such mixtures should be approached with great caution and that the oils might better be kept separate.

Dr. Barr has also mentioned the reclaiming of used diesel oils. The greatest of care must be used to be sure that the oil has been properly and completely reclaimed so that it is suitable for reuse. Then, of course, the additives will substantially all have been removed by the reclaiming process, so that these additives must be restored if the oil is to be used for diesel lubrication again. This involves adding the additives, and also, where more than one oil is used, involves the question of whether the used oils have been mixed and whether the additives to be used are suitable for the base oils involved. Dr. Barr has mentioned that different base oils require different amounts of additives and that an additive which will work with one base oil may not work with a different oil. Thus, if two or more used oils are mixed for reclaiming, care must be used in refortifying that suitable additives in proper quantity are used. Unless this is done trouble may be experienced with the reclaimed oil unless exhaustive engine tests show that the reclaimed oil may be safely used. On the whole, we are inclined to question whether it is not better to use reclaimed oils for other purposes than to attempt to use them in road engines. Although certain of the railroads have used reclaimed and refortified oils with fair success, many of them prefer to use such products in lighter service, such as switch engines or in service entirely separate from the diesel engines.

Finally, in connection with diesel engine oils, Dr. Barr has mentioned the activity directed towards writing a general specification for such oils. We agree completely with Dr. Barr that it is questionable whether this is desirable or whether it is even possible. Certainly, the usual physical specifications have very little meaning as to whether an oil will perform satisfactorily in an engine. Further, with the diversity of additives being used as detergents and as anti-oxidants, chemical requirements cannot be written. The only satisfactory tests for a diesel lubricating oil are performance tests and the writing of a performance test, involving full scale engine tests,

(*Continued on page* 200)

PROGRESS IN INSTRUMENT LUBRICATION[1]*

by Henry Gisser[2]

Mr. Gisser received his B. S. degree from City College, N. Y., and his M. A. degree from Columbia University. He has been associated with the Pitman-Dunn Laboratory, Frankford Arsenal, Philadelphia, Pa., since 1939, in research on organic coatings and instrument lubricants. At present, Mr. Gisser is head of the Organic Chemistry Section, Pitman-Dunn Lab.

Instrument lubrication constitutes a problem essentially different from the usual industrial lubrication processes. The goal in instrument lubrication is to lubricate the mechanism during initial assembly with a lubricant that will provide adequate lubrication under all anticipated conditions of use and storage for the life of the instrument, i.e., until the instrument requires mechanical repairs. This imposes a severe set of requirements on the lubricant, for, in addition to the usual requirement of reducing friction in the particular lubricated mechanism, and providing lubrication over a range of temperatures and relative humidities, the physical and chemical properties of the lubricant must remain sufficiently constant for adequate lubrication for an indefinite period of time. This is further complicated by the fact that most chemical changes in lubricants are catalyzed by metal and are autocatalytic so that changes may take place most rapidly during a storage period when there is no replacement of lubricant close to the metal surfaces.

For the purposes of this discussion, an instrument lubrication application is considered as one in which the mechanism is not readily disassembled for relubrication or one in which there is no provision for relubrication at intervals. This includes many mechanisms, such as electric motors, that are not instruments in the conventional sense, but the lubrication requirements of these mechanisms are similar to the lubrication requirements of instruments in many cases.

The general requirements of instrument lubricants may be summarized as follows:

1) Low volatility
2) Low temperature coefficient of viscosity
3) High oxidation stability
4) Rust inhibition
5) High physical stability
6) Moisture resistance

Specific applications may require special requirements such as:

1) Stability at very high temperatures for electric motor lubrication
2) Viscosity stability under high shear rates for hydraulic mechanisms.
3) Non-spreading properties for jewel bearing lubrication
4) Lead bearing capacity for use where high unit pressures are encountered.

Military requirements during the past ten years resulted in an intense research program which led to new compositions, new applications, basic studies in oxidation stability and its relation to the behavior of lubricated mechanisms, and methods of test. Among the most stringent of military requirements may be mentioned an operating temperature range of —40 to +160 F, and sufficiently high oxidation stability to enable the lubricant to retain its physical characteristics unchanged in a lubricated mechanism for upwards of twenty years. (The temperature range has recently been made more severe, i.e., —65 to +125 F with storage between —80 and +160 F. These are ambient temperatures, and in many instances, such as in motor bearing lubrication, the upper temperature limit is considerably higher.)

Prior to 1939, instrument lubricants were similar to the conventional greases and oils except that the raw materials were refined to a high degree. Shortly thereafter the use of lithium soaps in instrument greases became fairly common, although lithium greases had been used sporadically for several years previous. The use of lithium soap permitted the preparation of relatively high temperature greases that were moisture resistant. It was also found to be a relatively simple matter to inhibit lithium base greases to oxidation. By 1943, all of the instrument and aircraft control bearing greases supplied to the military forces were made with lithium soaps.

The extensive use of fatty oils, also quite common until fairly recently, has been largely abandoned. The materials provide excellent rust inhibition and a high degree of "oiliness," but have serious disadvantages in low oxidation stability and high freezing point. There is some belief that some of the desirable properties of these oils are due to the presence of free fatty acid. Attempts to lower the pour point or increase the oxidation stability of the oils by cold pressing leads to loss in some of the desirable constituent. At present the use of fatty materials in instrument lubrication is limited almost exclusively to jewel bearings for use at moderate temperatures, and even in this instance considerable difficulty is encountered because of gum formation requiring frequent cleaning and relubrication. Typical gummy deposits obtained with the use of a fatty oil on a ball bearing are illustrated in Figure 1.

The lubrication of watches and jewel bearings in

[1] Published with permission of the Department of the Army.
[2] Chemist, Pitman-Dunn Laboratory, Frankford Arsenal.
* Paper presented at 4th Annual Convention of A.S.L.E., New York City, April 12, 1949.

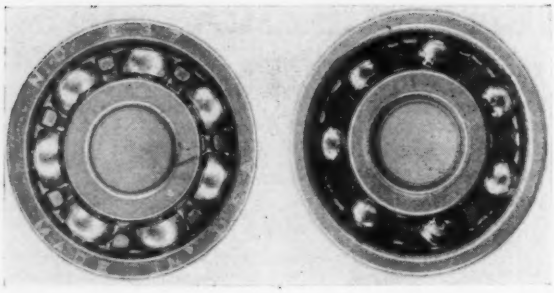


Fig. 1
New Bearing Bearing After Test with Fish Oil

general represents a rather unusual problem. In this instance, the ability of the oil to resist spreading is of paramount importance. This property is related to the interfacial tension between the oil and the lubricated surface. Unfortunately, most of the synthetic materials developed for use as instrument oils are of the spreading type and are not applicable to jewel bearing lubrication. Fatty oils, and more particularly fish oils, are traditional for this application, although they suffer from the disadvantages mentioned above. Some progress along synthetic lines has been made and one synthetic watch oil with good non-spreading properties has been marketed and has found considerable use. A great deal of work is in progress on watch lubricants however, particularly because of the severe temperature requirement for military purposes.

Oxidation Stability

Although the need for greases that were stable to oxidation has been recognized for many years, it was not until 1938 that a reasonably good technique for determination of the oxidation stability of grease became available. The oxygen bomb test of Wright and Mills [1] is now specified in all military specifications for instrument greases [2], and the American Society for Testing Materials has published a tentative method using this technique [3]. The relation between oxidation stability of grease as measured by the bomb test and the storage life of grease lubricated mechanisms was studied from 1942 through 1945 [4] and the results indicated a definite correlation between oxidation stability and storage life. For lithium-soap petroleum oil greases, it was shown that the storage life is 1-7 days at 167 F per hour of induction period in the oxygen bomb with copper catalyst at 210 F and 110 psi initial oxygen pressure. The bomb oxidation data appeared to obey the Arrhenius Equation.

The above results were obtained in storages conducted at moderately elevated temperatures in the absence of a corrosive environment. Since acids develop as one of the products of oxidation of lubricants, and since such acids may accelerate normal rusting or corrosive process at high humidity, it was reasoned that low oxidation stability may affect corrosion rate at high humidities, particularly in the presence of copper alloys. In a recently completed series of exposure tests in the tropics [5] this was found to be the case with both greases and oils. There have been numerous instances of ball bearing failure in the presence of copper alloys wherein corrosive processes were apparently at work. While there is little data to demonstrate the cause of failure, in most instances the difficulties were alleviated by using greases that were stable to oxidation.

The chemical changes in grease during oxidation in the bomb in the presence of copper catalyst have been investigated [6]. The pressure drop rate corresponds to the rate of formation of acid and rate of solution of metallic copper. This correspondence is independent of the presence of oxidation or sulphonate type rust inhibitors in the grease, for lithium base petroleum oil greases.

New Materials

The most significant change in the composition of instrument lubricants in the past few years has been the trend toward replacement of the petroleum oil with a variety of synthetic materials. Petroleum oils suffer from the disadvantage of having a narrow liquid range. In order to obtain finished lubricants for low temperature use, it is necessary to use low pour point and low viscosity oils which in turn are appreciably volatile. Volatility tests on a number of petroleum base instrument oils blended from 80-100 sec. stock using the ASTM evaporation technique [7] gave results varying from 10% to 40% volatile matter.

The use of the saturated aliphatic branched-chain esters of dibasic acids was suggested by Zisman and his co-workers [8] as base materials for both oils and grease. The range of utility of these compounds is indicated by the fact that diesters may be made having freezing points below —80 F and volatility of the order of one percent when tested using the ASTM technique. These materials lend themselves admirably to modification of their properties by the use of additives, and rust inhibiting blends of relatively high oxidation stability may readily be prepared. The kinematic viscosity indexes of many of the diesters are of the order of 150, which is considerably greater than that obtainable with petroleum oils without modification. Several of the diesters such as di-(2-ethylhexyl) sebacate and di-(2-ethylhexyl) adipate are available in considerable volume since they are used as plasticizers, and others are in pilot plant stages with potential availability in relatively large volume should the demand arise. It is of particular interest that the commercially available diesters have properties which make them particularly suitable for instrument lubricant bases, and they are sufficiently pure to permit their use without extensive refinement. In some applications, the viscosities of the diesters at moderate or elevated temperatures may be too low, in which instance a polymer modifier may be added. In this manner relatively high viscosity oils with good low temperature properties may be prepared, the polymer serving also to increase the viscosity index. For example, di-(2-ethylhexyl) sebacate with one percent Acryloid HF-880 yields a fluid having a viscosity index of 188 and a viscosity of 1760 cstks. at —40 [8]. Typical blended oils and greases from diester base fluids were described by Zisman and his co-workers [9].

The introduction of the silicone fluids opened new applications for high temperature lubricants. As a class, the silicones have a wider liquid range than any other class of fluids. The utility of these materials as lubricants is due to their unusually low temperature coefficient of viscosity and good stability at high temperature. Limited experience has shown that the silicones may not be suitable as lubricants for steel on steel or steel on cast iron combinations but there is some indication that a preliminary breaking in of the lubricated parts may alleviate the difficulty [10]. The low interfacial tension of the silicones with other materials may lead to slight leakage from conventional packings in hydraulic mechanisms. In spite of these apparent disadvantages, the unusual thermal properties of this class of compounds make their use in certain mechanisms particularly desirable.

Another class of synthetic materials of interest to instrument lubrication is the "Ucon" lubricants [11]. Developed primarily for engine use, these materials have a wider liquid range, higher viscosity index, and lower volatility than petroleum oils of comparable viscosity. These properties suggest that the fluids should be suitable as bases for instrument lubricants and some experimental products for this application have already been prepared.

Various other synthetic materials have been developed for use as instrument oils. Among these may be included long chain alkyl aryl ethers [12] and mixtures of arylphosphate esters with miscellaneous saturated esters [13].

Rust preventative additive studies on the silicone, diester, and "Ucon" oils and oxidation inhibitor studies on diester oils have been reported [9, 15]. Satisfactory inhibition could be obtained in all cases with the possible exception of the silicones, and in this instance, it appears that the difficulty is probably due to limited solubility of the additives in these silicone fluids.

Lubrication Technique

It has been recognized for some time that overlubrication is much less desirable than underlubrication. In instrument applications this is particularly true, especially if the lubricant is required to give good service over a fairly wide temperature range. Present instrument lubrication practice demands the use of a minimum amount of lubricant. Unfortunately however, ball bearing mounts and precision gear cases are still found equipped with grease gun fittings for replacement of old grease. This results in fully packed units which is undesirable. The alternative, disassembly and relubrication, is also undesirable. The development of highly stable instrument greases makes relubrication unnecessary and grease fittings on instruments will soon be a thing of the past.

In many applications where very low torques are available for moving parts, it has been the practice to use oil, since even after a short period of time, the stiffening of the grease due to oxidation or evaporation of the lighter ends of the base oil resulted in required torques being greater than available torques with consequent unserviceability. As a typical example may be mentioned the ball bearings of small synchro repeaters. Where feasible, oil cups or fittings are provided, but sometimes the mechanism is part of a large complicated assembly and frequent re-oiling is not feasible. In the latter instance it has been the practice to lubricate the parts with several drops of oil with the intention that this oil provide adequate lubrication for the life of the unit. This is obviously an unsatisfactory compromise, and experience has indicated that even with the best available oils, adequate lubrication is never achieved for a period of more than two years. At best, where frequent re-oiling by means of fittings is feasible, the oil eventually drains to parts of the mechanism which should be kept clean so that disassembly for cleaning is still required. If the unit must be stored for any period of time, re-oiling schedules cannot be maintained, and failure of the mechanism may be anticipated because of corrosion or oxidation of old oil with the formation of gummy materials. With the development of stable greases it appeared that grease lubrication might be feasible for these critical low torque ball bearing applications. Experimental work using grease lubrication on precision ball bearings in both storage at slightly elevated temperature [14] and tropical exposure [5] gave promising results. This work was done before the development of the low viscosity low volatility synthetic fluids, and petroleum oils were therefore used. In the above work, rate of decrease of performance was measured by actual bearing performance at extremely low torques and low speed. The lubricants tested and the results are described in Table I. It is evident from these data that grease lubrication may solve the problem of lubrication of low torque precision ball bearings.

Within recent years more emphasis has been placed on the cleanliness of lubricants and application techniques. This is a dual problem since not only is the question of packaging involved, but the lubrication process itself must be done under practically ideal conditions. The former is primarily a question of cost, while the latter is a question of education. Fine dirt particles may be readily removed from oils by filtration, while with grease the dirt removal problem is somewhat more difficult because of the greater complexity of packaging equipment. This can readily be accomplished, however, although the cost of the final product is consequently more. The education of instrument assembly and maintenance men to a higher degree of cleanliness in applying the lubricant is somewhat more difficult. Proper instrument lubrication technique calls for the application of a minimum amount of grease spread uniformly over the bearing surface. This is generally accomplished with a toothpick or similar means and dirt may readily be transferred to the grease container. It would appear that the best type of packaging for instrument grease is a container such as a collapsible tube so that contamination of the grease with extraneous matter is avoided. Instrument grease supplied to the Army during the war was packaged in this way with excellent results. The next step is the use of an applicator permanently attached to the tube, and having a suitable cover to prevent the tip of the applicator from accumulating dirt when not in use. Packaging of this type is already under consideration.

At this point it is desirable to consider the cost factor in instrument lubrication. The use of synthetic materials of a relatively high degree of purity, the need for extreme cleanliness, expensive packaging, and the small volume of material used makes for a high cost of packaged lubricant. Since the total lubricant used for a single instrument is small in volume, and since the use of a high grade lubricant makes expensive and time consuming overhaul less frequent, the cost of the lubricant should be considered as a minor factor.

TABLE I

DATA ON GREASE LUBRICATED PRECISION BALL BEARINGS

Lubricant	*Adherence to Metal*	*Oxidation Stability*	*Rust Prevention*	*Weeks for Failure in storage at 140 F*	*Angular error increase after 18 months' tropical exposure*
Petroleum Base Instrument Oil—A	Poor	Fair	Good	33.7	0.10
Petroleum Base Oil—B	Poor	Poor	Good	23.0	0.33
Ether type Synthetic Fluid Oil—C	Good	Fair	Fair-Poor	22.5	0.93
Uninhibited Petroleum Instrument Oil—D	Poor	Good	Poor	9.8	1.40
Fish Oil—E	Good	Poor	Good	11.5	0.65
Stable Instrument Grease (Low Temperature Type)	Good	Fair	Good	25.5	0.10

Test Methods

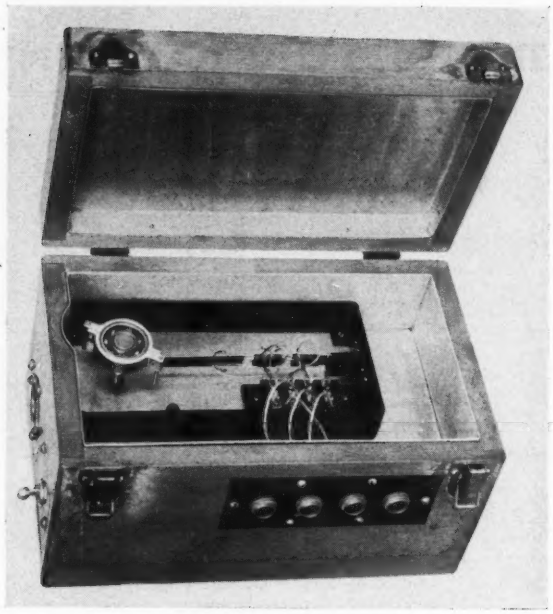
Along with the development of new materials for instrument lubricants there has been considerable progress in test methods. Typical laboratory tests on instrument oils have been described by Barker and his co-workers [15]. The greatest progress has been made in oxidation and rust prevention tests. This progress has been both in new techniques and in interpretation of the data obtained. The present trend in oxidation stability tests on oil is to pass oxygen or air through the oil at elevated temperature in the presence of one or more metals as a catalyst, with determination of the change in neutralization number and viscosity of the oil, change in weight and appearance of the metal catalyst, amount of volatile acid formed, and amount of sludge or insoluable matter formed. It is only recently that emphasis has been placed on the volatile acid. The lower molecular weight fatty acids, which are frequently lost during the oxidation processes because of entrainment by the stream of air or oxygen, are quite corrosive to steel and knowledge of their rate of formation under oxidizing conditions is of importance. The oxidation conditions and determination of end products may readily be modified to be in accordance with the type of material being tested and consideration of its use. Thus low viscosity petroleum oils may increase considerably in viscosity because of loss of volatile fractions, so that viscosity changes may have little meaning. On the other hand, some of the synthetics do not readily form polymerized products or sludges, but may give rise to a considerable quantity of volatile acid. The use of synthetics makes the latter point of considerable importance, because the oxidation techniques for instrument oils originated when petroleum oils were used almost exclusively and these do not give rise to large quantities of low molecular weight acid except after long oxidation or unless the oil is very unstable. Determination of oxidative end products is now undergoing re-examination so that the oxidation tests will be fitted to the chemistry of the material being oxidized. To further this end, experimental work is in progress on detection and determination of the products of oxidation of lubricants.

The oxidation test technique for grease has changed very little since the use of the oxygen bomb [1] was introduced. Most of the progress in grease oxidation has been in interpretation of results and correlation of results with storage stability, which was mentioned earlier.

Extensive experimental work has been done on the development of laboratory techniques for measuring the rust preventative characteristics of lubricating oils. Almost all of these techniques, both old and recent, depend on either exposure to high humidity or contact with liquid water as the corrosive medium. Successful use of these techniques are attended by two major problems; first, reproducibility of the test results, and second, correlation of the results with service behavior of the materials being tested. While these problems are associated with all laboratory tests on lubricants, they seem to cause exceptional difficulty in connection with anti-rust tests. Frequently two test methods using the same corrosive medium order a series of materials in different ways. This may be due to poor reproducibility with consequent large insignificant differences, or to differences in the mechanism of activity of the corrosive environment. In spite of these difficulties, considerable progress has been made in improving the technique for rust preventive tests. The improvements include both better control of the overall test conditions and techniques of essentially new design to enable close control of the environmental conditions in the neighborhood of the test specimens. The "Todd" humidity cabinet [16] aims at reducing uncontrolled condensation and widely varying ambients in the neighborhood of the test specimens by surrounding the cabinet with a chamber filled with the vapor of a refluxing solvent. The entire cabinet is thus immersed in a bath at constant temperature. The Army-Navy design of a nominal 100% relative humidity cabinet [17], which aims at closer control of the over-all conditions, is now in process of standardization. The static water drop test of the Naval Research Laboratory [18] involves a system wherein a drop of water is placed on a steel specimen previously covered with oil. Since the system is at rest, there is no opportunity for replacement of the additive film on the steel, and the test measures essentially the ability of the initially absorbed additive film to prevent rust formation by the water. The fog cabinet of the Naval Research Laboratory [18] causes a fine water mist to impinge against the specimen, exposing the latter to leaching and rusting by the water. Various other techniques such as controlled condensation [19] on the specimens have been studied along with improvements in the preparation of the test specimens [20].

The recently suggested A.S.T.M. method for volatility [7] represents an improvement over open dish volatility techniques. The sample, which may be oil or grease, is exposed to a controlled air flow in a cell of controlled geometry. This method is capable of very high reproducibility. The S.O.D. pressure grease viscosimeter permits measurements of grease viscosity as a function of rate of shear. The unit has been adopted for low temperature measurements and has enabled determination of maximum permissible grease viscosities for low temperature operation of instruments.

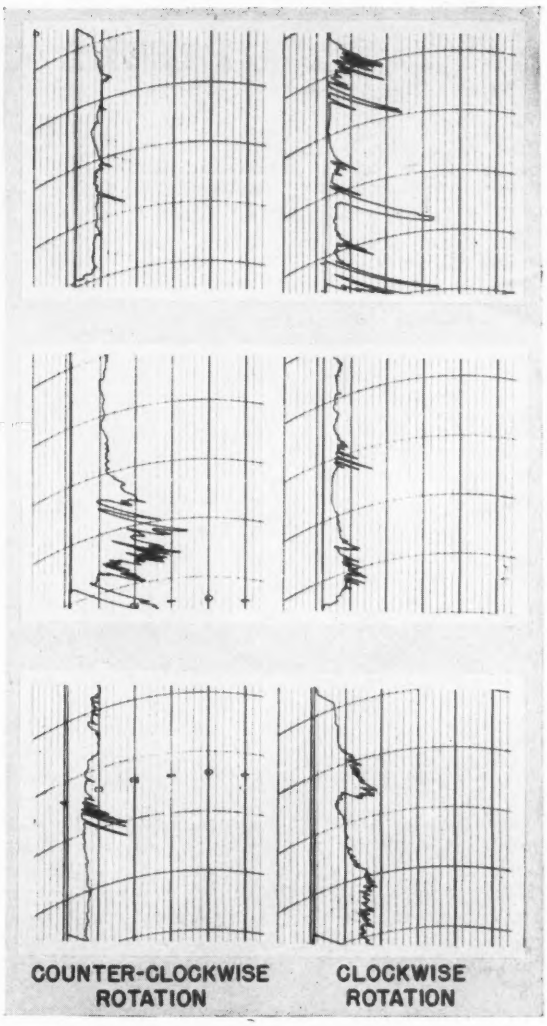
In running performance tests on lubricants, it has been the practice to operate some mechanism with the lubricant under test under controlled laboratory conditions until failure is encountered. In many instances the deterioration rate is accelerated by increasing the temperature or speed of operation or both. High speed, high temperature ball bearing tests are typical of this type of testing. Unfortunately, this general technique of measuring time to failure is not always applicable to studies on instrument lubricants, particularly where changes that occur over a long period of time are of interest. Since storage failure requires a considerable period of time (ideal lubricants are intended to last practically indefinitely), the concept of time for failure cannot be used, and it is therefore necessary to have some measure of change in performance in the range in which the mechanism is operating properly. In some instances the mechanism under study lends itself to this type of measurement. For example, in studying lubricants for synchronous units, it is feasible to measure the error in response within the permissible error range. In the general case this type of measurement is not feasible. The small precision ball bearing or hand operated mechanism of a precision instrument may be taken as a general example. What is desired is the relative breakdown rate of the lubricant in the lubricated mechanism. Operation of the mechanism by hand after a suitable storage period with observation for grittiness, stiffness, etc., is generally relied on as an indication of failure or impending failure. Conditions may not be accelerated too greatly because of danger of introducing a deterioration mechanism that does not operate during normal service. On the other hand, considerable deterioration must take place before such deterioration may readily be detected by the usual meth-



Bearing Tester (Fig. 2)

od. This problem led to the development of automatic torque measuring equipment applicable to ball bearings [21] and to slow, low torque movements of precision instruments. In both of these units, the torque required to turn a mechanism is transmitted to a spring arm, to which is attached a number of strain gages wired as the arms of a resistance bridge. The bridge unbalance resulting from bending of the spring is amplified and recorded. This gives a curve of torque vs degree of rotation for any preselected speed. From this curve may be obtained starting torque, running torque, and torque variation, the latter being a measure of grittiness. This technique enables the measurement of torques considerably less than one gram centimeter. Typical tests [21] have demonstrated that ball bearings whose motion qualities cannot be differentiated by trained operators show widely differing degrees of grittiness in the low torque range when tested by this device. A typical ball bearing test unit is illustrated in Figure 2, and a typical torque vs degree of rotation curve in Figure 3.

Statistical methods of data analysis are finding wide use in lubricant test and development work. Contrary to the usual impression, these methods enable the use of fewer test speciments and are almost essential where methods giving poor reproducibility must be used in test work. Since most of the tests conducted on instrument lubricants are empirical in nature, and performance tests are attended by a great many variables some of which are difficult to control, the need for statistical tests for significant differences is obvious. Widely varying tests results in ball bearing tests have been obtained by all workers in this field and interpretation of the data appears almost hopeless without a statistical tool. As a simple (non-rigorous) approach to the analysis of data, the probability of occurrence of an experimentally observed difference due to random causes among two lubricants (or specimens) is calculated and compared with a preselected "level of significance." For example, if the selected level of significance is 5% and the probability of occurrence of the difference due to random causes is less than 5%, the difference is said to be significant, i. e., a real difference exists between the lubricants



Typical Torque-Time Curves on No. 37 Bearings (Fig. 3)

being tested. In this way, the data analysis takes poor reproductibility into account. Techniques for statistical analysis of data may be found in any of the texts on the subject.

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(*Continued on page* 197)

SOME ASPECTS OF DIESEL CYLINDER LUBRICATION*

Mr. Watson graduated from the University of Rochester with the Bachelor of Science degree in Mechanical Engineering, and from Cornell University with the Master of Science degree in Engineering.

From 1939-46, he taught at Cornell in the Dept. of Mechanics and Dept. of Engineering Materials. During the war, he was one of several civilian supervisors of the instruction program in the diesel engineering course given for Naval officers.

As Associate Professor of Mechanical Engineering at Cornell, his instruction is in the field of diesel and internal combustion engines. Mr. Watson also directs the activities of the extensive diesel laboratory which was transferred by the Navy to the University at the conclusion of the Naval program in 1946.

by E. B. Watson
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One of the most challenging problems encountered by the diesel engine designer is to secure satisfactory lubrication of the engine cylinders. How well this problem is solved determines to a large extent the success of any diesel engine design. When correct cylinder lubrication prevails in an engine, the following objectives will be achieved:

1. The rate of wear of cylinders, pistons and piston rings will be within acceptable limits.
2. The rate of formation of piston deposits will be minimized.
3. Oil consumption will not exceed acceptable limits.

The failure to attain in a given engine any one of these objectives is sufficient reason to judge the cylinder lubrication practice as unsatisfactory. The attainment of these objectives is imperative if troublefree engine performance and freedom from excessive engine maintenance is to result, and may be expected only when the engine designer and the lubrication engineer work together in full cooperation. It is the responsibility of the designer to provide, in so far as possible, an environment in the cylinder favorable for satisfactory lubrication without imposing unreasonable demands upon the lubricant. Equally as important is the lubrication engineer's responsibility to recognize the factors in the design of a diesel engine influencing lubricant performance and to give these factors due consideration when recommending a cylinder lubricant. Through the activities of technical societies such as this, cooperation between members of both groups is encouraged. Working together engineers from the diesel and petroleum industries will continue to solve in the future, as they have in the past, many perplexing problems associated with cylinder lubrication. It must be emphasized, however, that the combination of a well-designed diesel engine and a carefully selected high quality diesel lubricant is not enough to insure satisfactory engine lubrication. Fortunately the diesel operator is becoming increasingly aware that optimum engine performance and longevity can be obtained only when he follows correct engine operating and maintenance procedure.

The basic objective of cylinder lubrication is the formation and maintenance under all engine operating conditions of an oil film between mating surfaces. Were it possible to insure the existence of a sufficiently thick film to prevent metallic contact, friction, and consequent wear of cylinder walls, piston and piston rings would be minimized. Furthermore such an oil film would act as an effective sealing agent to assist in preventing blowby of combustion products to the crankcase. Conditions favorable to the formation of a thick oil film and hydrodynamic lubrication may exist during a portion of the piston stroke. As the piston moves through its top center position, however, its velocity is reduced, reversal of direction occurs, maximum pressures exist behind the piston rings causing maximum loading on the oil film. The quantity of oil reaching the upper cylinder wall is scanty and its viscosity low as a result of the high temperatures prevailing in this region. It is clear that all these factors mitigate against the maintenance of a thick film and that boundary lubrication must exist during this portion of the piston stroke. The normal pattern of cylinder wear, undistorted by unusual factors, shows the region of maximum wear to occur opposite the top dead center position of the top piston ring.

A search of the technical literature for information upon the basic factors related to oil film formation, oil distribution over the cylinder wall, the behavior of piston rings, and other fundamental aspects of the cylinder lubrication problem yields only a limited amount of material. Several reasons may be advanced for this: (1) the experimental difficulties associated with the study of cylinder lubrication phenomena of this type, and (2) the allocation in the past of research facilities to the study of more immediate problems related to cylinder lubrication. Frequently lubricant stability and detergency characteristics, fuel characteristics, and engine design or operating factors will exercise a greater influence over cylinder lubrication than factors related to the theoretical aspects of film formation. The technical literature contains a number of reports of excellent research of this later type, and much information is available to guide lubrication engineers and engine designers in solving problems in which factors of this type exert the dominant influence. It is encouraging to note, however, that a considerable number of laboratories are currently engaged in programs directed toward the elucidation of the principles governing cylinder and piston lubrication. As an example of this type of research I would refer to recent work done at the NACA and Shell Development laboratories, during

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which photographic studies were made of cylinder lubrication phenomena in glass cylinder engines. Continued work of this nature and the development of new experimental techniques promise to soon broaden our understanding of the fundamental aspects of this complex process.

Two recent publications will be of interest to those of you concerned with piston and cylinder lubrication.

1. Wear and Lubrication of Piston Rings and Cylinders by R. Poppinga.
2. Wear—As applied particularly to Cylinders and Piston Rings. The authors of this book are Dr. F. B. Bundy, General Electric Company who prepared the section on Wear Theory and Research, T. E. Eagan, Chief Metallurgist of the Cooper-Bessemer Corporation who prepared the section on Metallurgical Consideratons in Wear Resistance, and R. L. Boyer, Vice-President and Chief Engineer of Cooper Bessemer, author of the section on Design Aspects of Cylinder and Ring Wear.

These books represent significant contributions to the literature in the field and will be welcomed by engine designers and lubrication specialists.

When one recalls the conditions existing in the cylinder of a diesel engine, he finds it difficult sometimes to perceive how it is possible for any oil film to remain on the upper cylinder wall. Direct measurement by Uyehra and Meyers at the University of Wisconsin has shown the existence of flame temperatures of 3000-4000F during combustion in a diesel engine existing for 30-60 degrees of crank rotation. One side of the oil film on the cylinder wall is exposed to these temperatures, the other side to lower cylinder wall temperatures. Upper cylinder wall temperatures of 350F-400F have been measured opposite the top piston ring. Upper piston ring groove temperatures of the order of 500F are not uncommon. It is clear that whatever oil film does exist on the upper cylinder wall will necessarily be thin, NACA photographic studies indicated in their glass cylinder engine a film thickness between the wall and the upper piston ring of approximately 0.0001 inch, and unless fresh oil is continually supplied to the region to replace that lost by evaporation an unlubricated dry wall will exist.

Cylinder wear in the diesel engine is a result of several processes, not all of which may always be operative:

1. Abrasion of mating surfaces when metallic contact occurs due to the rupture or evaporation of the oil film.
2. Scuffing due to high temperature flashes at points of metallic contact causing temporary weldments of the mating areas.
3. Erosion due to the action of foreign contaminants between the mating surfaces.
4. Corrosion due to the action of corrosive compounds formed from incomplete combustion or by the action of condensed water and products of complete combustion.
5. Surface disintegration due to fatigue failure of the cylinder surface.

The rate of abrasive and scuffing types of wear, and indirectly, the corrosive type, is a function primarily of lubricant properties; engine design factors such as method of cylinder lubrication and types of piston rings; and metallurgical factors such as materials and surface finish properties of pistons, piston rings, and cylinder walls. Erosion wear is a result of oil contamination by foreign particles and can be effectively controlled by adequate air, fuel, and lubricating oil filtration. Corrosive wear appears to be related primarily to fuel characteristics and operating conditions although influenced by lubricant properties. Surface fatigue, a type of failure mentioned first in the literature by H. J. Young and discussed thoroughly by Payne and Joachim in a recent paper before the Society of Automotive Engineers, appears to be intimately related to methods of machining cylinder liners.

The three lubricant properties exerting the greatest influence over the rate of wear due to abrasion and scuffing are (1) viscosity, (2) volatility, and (3) additive treatment. The use of the lowest viscosity oil consistent with normal wear rates is generally desired since engine friction is reduced, lower oil temperatures prevail, and, in some instances, significant improvements in fuel economy or power output result. Numerous investigators have shown, however, that if the cylinder lubricant viscosity is too low, the rate of wear will increase. As a compromise between friction and wear and oil consumption, it appears that the optimum viscosity for diesel cylinder lubrication is between 50 and 75 SSU at 210 F. To obtain satisfactory starting of high speed automotive type diesel engines after exposure to low ambient temperatures, it is generally necessary that an oil of lower viscosity be used. Correct viscosity specifications for an engine are not always predictable in advance and may require alteration when operating conditions are changed. One manufacturer found it necessary, in order to control cylinder and ring wear in an engine for installation in the tropics where a continuous air intake temperature of 120 F was expected, to alter both the piston and piston ring design and to increase the viscosity of the cylinder lubricant.

The viscosity of the lubricant for the cylinder walls will depend upon the method of its supply to the cylinders. Small and moderate bore engines of medium and high speed depend upon oil splash from the crankcase for cylinder lubrication. In these engines the same oil lubricates both bearings and cylinder walls and its viscosity represents a compromise between that required for cylinder lubrication and for proper bearing lubrication. Adequate bearing lubrication is generally obtained with oils of lower viscosity than required for cylinder lubrication. In large bore slow speed engines direct cylinder lubrication is employed and measured quantities of the proper viscosity lubricant are delivered to the cylinder walls by the lubricator. In these engines, if desirable, a higher viscosity lubricant may be used for cylinder lubrication than used in the crankcase for bearing lubrication. To simplify the supply and storage problems, however, many such installations use the same oil for cylinder and bearing lubrication.

Lubricating oil volatility characteristics determine its ability to remain upon the cylinder wall under exposure to the temperatures prevailing in the cylinder. A more volatile oil may evaporate from the wall at a rate greater than that at which fresh oil is supplied, thus leaving the cylinder wall momentarily free of a protective oil film. Hollister has shown that greater wear of cylinders and piston rings will occur with the more volatile oil of two having the same viscosity at temperatures prevailing on the cylinder wall.

By selection of an oil of proper viscosity and volatility an acceptable rate of cylinder wear can usually be obtained. In some instances, however, the wear prevention ability of straight mineral oil may be improved by the inclusion of suitable additives. Certain additives have been developed to improve the ability of an oil to wet and adhere to the hot metal surfaces in the cylinder,

thus assisting the oil film to resist rupture, and improve the oil's ability to reduce friction and wear under boundary lubrication conditions.

The formation and maintenance of an oil film on the cylinder wall and the reduction of wear due to its presence can only occur if a sufficient amount of oil reaches and is effectively distributed over the cylinder walls. When splash lubrication of the walls is utilized, more oil generally reaches the lower cylinder walls than is required for adequate lubrication. The oil control rings on the piston, as well as the compression rings, must limit the amount of oil allowed to work past the rings to the upper cylinder walls otherwise oil consumption will be excessive. Properly selected ring combinations will effectively control oil consumption yet will permit sufficient oil to reach the upper regions of the cylinder so that as evaporation of the oil films transpires, new oil is available to replace it. There is no easy way to success when selecting a ring set for a new or modified engine design. When, after considerable development work, a proper piston ring combination is selected, it represents a delicate balance between oil consumption and wear control.

The amount of wear in a given period in automotive diesel engines, where priming of the lubrication system before starting is impossible, has been shown to be a function of the number of starts during the interval. The greater wear under these conditions, as compared with the wear in the same engine operating for the same period of time continuously, may be attributed to the wear occuring during and immediately following the starting period before oil has reached or has been distributed over the cylinder walls. Lower viscosity oils alleviate this difficulty, but may cause greater oil consumption due to the ease with which they work by the oil control and compression rings into the combustion chamber, there to be consumed.

Where cylinder lubricators are used, it is possible to exert a greater degree of control over the rate of oil consumption. Because of the large cylinder diameters of engines of this type somewhat more difficulty may occur in distributing the oil over the entire cylinder wall. To assist in distribution oil may be delivered to the cylinder wall through several outlets, perhaps 4, 6, or 8, properly located around the cylinder. Distribution grooves are sometimes formed in the piston skirt or in the cylinder wall.

Under some engine operating conditions and with certain type fuels recent investigators have shown that corrosive wear may exceed in magnitude wear due to abrasion and scuffing. With low sulfur fuels corrosive cylinder wear is primarily a function of jacket water temperature. When cylinder wall temperatures are below the dew point, condensation of water vapor from combustion occurs and corrosive acids may be formed by its absorption of CO_2, SO_3, or NO_2 from the combustion gases. This type of wear has been recognized by diesel engineers for some time, and its effect may be minimized by proper operating procedures. Recent investigations have indicated, however, that greatly accelerated wear rates may occur when operating temperatures are normal if high sulfur content fuel oils are used. The exact process, by which high sulfur fuels cause increased wear at normal temperatures is the subject of some controversy. According to one theory SO_3, formed during combustion, attacks the oil film on the cylinder wall thus leaving the surface unprotected and subject to corrosion or increased abrasive wear. An alternate theory suggests that the increased deposits noted when high sulfur fuels are burned, may increase the erosive type wear. Although investigators in this field may not agree as to the exact cause, all recognize that increased wear and engine deposits with high sulfur fuels is a problem of increasing importance since all evidence indicates that future diesel fuels will contain more sulfur than commonly considered desirable today. The effects of high sulfur fuels may be overcome by developments in engine design and in lubricating oils. Lubricants already available are specifically compounded to combat the evils of the high sulfur fuels and are of proven effectiveness.

Reduction in cylinder wear rates beyond that which can be accomplished by the choice of the proper lubricant and by proper lubrication system design has been obtained by considerations of the metallurgical and surface finish factors related to engine wear. An important development of this type is the use of porous chrome plated cylinder liners. Payne and Joachim have shown "that the average wear rate of 0.0006 in. per 1000 hrs. for porous chromium plating during comparative tests of six heavily loaded 2 cycle engines was only one-fourth that of non-plated cast iron in the same engines." This improvement is not unexpected since the abrasion and corrosion resistance of chromium is well known. Early experiments with chrome plated liners were unsuccessful because the need for a porous surface with oil retention qualities was not appreciated.

Scuffing wear, of greatest import during engine break-in, has been greatly reduced by various chemical treatments for piston ring and liner surfaces. Treatment of these parts results in a surface coating of metallic oxide, phosphide, sulphide, or other chemical type being formed which assists to prevent metallic areas which break through the oil film from welding under high flash temperature conditions.

The dependence of cylinder wear upon factors other than those related strictly to lubrication practice has been indicated. It is quite evident that additional gains in the achievement of longer wearing surfaces will be attained only through the combined efforts of the physicist, the chemist, the metallurgist, the engine designer, and the lubrication specialist. Consistent progress toward this objective is being made, and, although such progress is not easily achieved, the rewards in terms of improved engine performance and reliability are consistent with the efforts expended.

The very interesting paper by Payne and Joachim, referred to previously, entitled "Investigations on Cylinder Liner Wear" will be of real interest to everyone concerned with diesel engine lubrication. The effect of engine design factors and operating factors upon cylinder wear in a group of twenty-four Naval type diesel engines including both two and four stroke cycle types with cylinder bores ranging from 3⅝" to 12¾", piston speeds of 1000—2000 fpm., and BMEP's of 70—114 psi is presented. This is one of the most comprehensive discussions of the subject of wear and lubrication of diesel engine cylinders to appear in recent literature.

If the only problems associated with cylinder lubrication were cylinder wear and oil consumption, the engine designer's and the lubrication engineer's job would be much simpler. They must, however, contend with the problem of piston and ring belt deposits. The build up of lacquer and varnish deposits on the piston skirt may impair heat transfer from the piston, will reduce clearances, and may eventually cause piston failure. The build up of hard erosive deposits on the piston crown above the top ring may result in increased cylinder and

ring wear. The accumulation of deposits in the ring grooves will eventually result in pinched or stuck piston rings. The loss of proper ring action in a diesel engine is serious as the subsequent increased blowby and loss of compression leads to poor combustion, piston burning, increased deposit formation, and ring breakage. For satisfactory engine performance to be assured over reasonable periods, the engine design and the lubricant selected must be so related that the rate of build up of piston deposits is not excessive.

Engine deposits originate from several sources, namely (1) foreign materials introduced with the air, (2) products of incomplete combustion of the fuel, and (3) deterioration of the lubricating oil. While deposits of the first type are of real importance, adequate air filtration should reduce their effect to a minimum.

The conventional combustion equation for diesel fuel indicates that the products of combustion would be composed of CO_2 and water vapor. If such were true in the actual engine, many diesel engines would experience little difficulty due to engine deposits. The degree, to which complete combustion is achieved in the diesel engine depends upon the success, with which fuel and air are mixed in the extremely short period available and the temperatures which prevail in the combustion chamber during the combustion process. In large diesel engines the injection system plays the greatest part in insuring fuel-air mixing, and it is necessary for the system to be so adjusted that proper atomization of the fuel is secured and so that the tiny droplets are properly dispersed throughout the air in the combustion chamber in order that each may be completely consumed. During the combustion process fuel molecules are subject to two influences; a molecule may be cracked to form hydrocarbons of lower molecular weight as well as free carbon; or the molecule may be partially ozidized to form an aldehyde, organic acid, or some other product. High temperatures in the combustion chamber favor the cracking reaction, low temperatures the formation of products of partial oxidation. If these intermediate products find oxygen and are not chilled below reaction temperatures, they will be consumed, otherwise they will either be discharged with the engine exhaust causing objectionable smoke or odor, or trapped in the clearance volume, thus contaminating the oil film and lodging on the surface of the piston, and in the ring grooves. Excessive amounts of unburned free carbon generally occur only in overloaded engines where high combustion chamber temperatures and a deficiency of air exist. The formation of intermediate oxidation products will be most severe when the engine operates at idle or light load. Either condition can quickly give rise to objectionable engine deposits and accelerates ring sticking and other troubles attributable to deposit formation. Fuel characteristics, particularly cetane number and volatility, influence the rate at which deposits originate from the fuel. High speed automotive engines operating under variable speed and load conditions are more sensitive to fuel characteristics than the lower speed industrial engine operating at fixed speed and relatively constant load.

If piston deposits and ring sticking are to be prevented, the operator of a diesel engine must discharge his responsibility to properly maintain the engine, particularly its injection system, to use suitable fuels, and to operate under recommended conditions avoiding excessive idling or overload.

The rate of formation of piston deposits due to lubricating oil deterioration is influenced by the nature of the lubricant and the design of the engine. The primary cause of lubricant deterioration in an engine is oxidation, the reaction of the oil molecule with oxygen. Products of early stages of oil oxidation remain soluble in the oil causing it to discolor and to become corrosive to some types of bearing materials. As oxidation continues, the concentration of oxidized material exceeds the solubility of the oil, and some oxidized compounds precipitate to form deposits on the piston skirt, in the ring grooves, etc. These materials, subject to the temperatures prevailing at the point of deposition, may then form lacquer, as on the piston skirt, or carbonaceous residues, as in the ring grooves. The rate of oxidation of lubricating oil is a function of time, temperature, catalytic effects, exposed surface, and oxidation stability, itself a function of the base stock, the method of refining, and additive treatment. The effects of these factors upon the rate of oxidation is well known and requires no elaboration at this time.

To control the rate of formation of oxidation deposits two methods are available: (1) improvement in the oxidation stability of the lubricant, and (2) prevention by proper design of conditions favorable to rapid oxidation. The use of oxidation inhibitors in the oil can greatly reduce the rate of oxidation and has effectively assisted in controlling the formation of piston deposits.

The time factor, so important in its effect upon rate of oxidation, is a function both of lubricant properties and engine design. The more volatile lubricants will frequently reduce piston deposits since they evaporate from cylinder and piston surfaces before having time to reach advanced stages of oxidation. Increased wear may result, however, unless the rate, at which oil is supplied to the critical region is sufficient to insure immediate replacement of the oil film. Therefore the lubrication enginer must, when choosing an oil for an engine, balance the effect of its volatility upon wear and deposits and strike a successful compromise. The engine designer should attempt to provide a sufficient flow of oil over surfaces upon which deposits will occur to effectively remove partially oxidized products before they can develop into harmful deposits. Here again it is necessary to compromise, however, since experience indicates that excessive oil flow to the high temperature regions will increase the rate of deposit formation.

The temperature factor is determined by engine design, particularly piston design. An appreciable portion of the heat absorbed by the crown of an uncooled piston flows from the crown to the piston rings and piston skirt, thence through the oil film to the cylinder wall and water jacket. For heat to flow a temperature gradient must exist. This results in high temperatures at the ring belt zone, somewhat lower temperatures at the piston skirt. A number of investigators have shown that piston temperatures can be controlled by proper design so that excessively high temperatures at the ring belt are avoided and ring sticking minimized. Other designers, particularly in engines of high specific output, high BHP/in^3 of displacement, have controlled piston ring belt temperatures by removing a significant portion of the heat absorbed by the piston by an oil spray on the underneath side of the crown or by circulation of oil through a cavity in the crown.

The catalytic effect of copper, finely divided iron particles from engine wear, and water upon the rate of oxidation can be avoided by proper design, adequate oil filtration, and proper operating conditions.

Particularly effective in high speed diesel engines to reduce ring sticking and improve general engine clean-

(*Continued on page* 197)

DISCUSSIONS ON PAPER
"IMPROVED HIGH-SPEED ROLLER BEARINGS"

by Donald F. Wilcock
and
Frederick C. Jones

Paper published in LUBRICATION ENGINEERING
(Vol. 5, No. 3, 129-133, June, 1949)

BY FRANK W. WELLONS
SKF Industries, Inc.

It is particularly encouraging to have Dr. Wilcock report that none of the cage designs covered by this very thorough investigation including the conventional unplated yellow brass cage showed any distress under continuous lubricated conditions. However, we inherently have less trouble with roller bearings than with ball bearings at high speeds and the normal operating conditions for this test are not so severe as those we must meet for future turbine developments. In this test the speed factor, that is the bore in m/m times the RPM was about 700,000 while to keep pace with the turbine people, both ball and roller bearings must operate successfully at speed factors of at least twice this value and last thru overhaul periods several times current practice. Too little experience is available at these extreme speeds but we have learned the hard way that the retainer must be held to precision limits for flatness of the cage support surfaces, concentricity and general geometrical accuracy.

We recently conducted some low speed tests under heavy combined loads with split inner race ball bearings using one piece brass cages, brass cages silver plated and silver plated cages with a lead tin overlay. With a safe oil flow of about one pound per minute we could see no apparent advantage of either of the plated cages. However, at extreme speed even with relatively high oil flow, the cage lubrication will be critical and will require either plated cages or cages made from materials having excellent bearing properties in conjunction with the rolling element in the cage pocket and also with the very narrow land on the race supporting the cage.

BY DANIEL GURNEY
Vice President—Chief Engineer
Marlin Rockwell Corporation

Dr. D. F. Wilcock and Mr. Frederick C. Jones have presented a very interesting and instructive discussion of their tests and testing machine for the investigation of the performance of 95 millimeter cylindrical roller bearings under simulated aircraft gas turbine conditions. This type of roller bearing was developed during the last 10 or 15 years for use in reciprocating aircraft engines. For this service it has been eminently successful. A bearing having high load carrying capacity and highest reliability was required. The bronze separators, to space the rollers in the bearings, were designed for this service. They had to be light, and in order to withstand the impact load, caused by heavy explosion pressures, they had to be very strong. For this reason, the bronze separator material was chosen primarily for strength, and secondarily, for bearing properties. Thus we have a separator which is perfectly suited to reciprocating engine service, and has given remarkably reliable, trouble-free service.

The advent of the aircraft gas turbine brought a requirement for ball and roller bearings capable of operating at speeds of from 6,000 to 13,000 RPM. The same aircraft engine roller bearings were admirably suited to this service provided they were refined slightly in dimensional characteristics. The performance of these bearings was very satisfactory in the early gas turbines at these very high speeds. In reciprocating engines these crankshaft main bearings rotated at speeds up to about 2,800 RPM. Splash lubrication was perfectly satisfactory at these speeds, but at the higher gas turbine speeds jet lubrication was found to be necessary. A solid jet of oil, carrying as much as ½ gallon of oil per minute directly into the bearing, is used. This practice was developed for use in very high speed ball and roller bearings used in supercharger service. With this method of lubrication we have been able to use both ball and roller bearings up to speeds as high as 30,000 or 40,000 RPM.

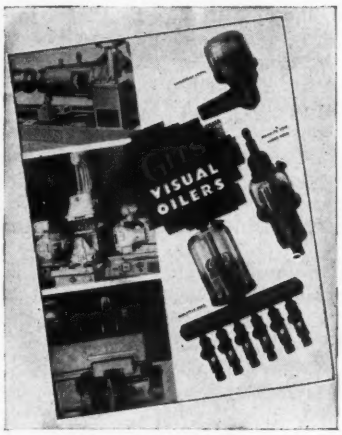
These gas turbine main shaft ball and roller bearings operated very successfully with this type of lubrication, even though the loads were very great and the speeds very high. However, on the larger turbines new problems came into being. Temperatures at the turbine wheel bearings increased. As Dr. Wilcock intimates, these temperatures, particularly at shut-down, get so high that the Grade 1010 oil in the bearing vaporizes, leaving a varnish-like deposit. To add to this difficulty, the turbine is started and accelerates very rapidly. During this acceleration the lubricating oil is slow in reaching the bearings, so that rated speed is reached before the bearing receives adequate lubrication. Under these circumstances, the brass separators sometimes fail where they operate as plain bearings on the outside diameter lands of the inner race. Also they sometimes seize on the rollers and bearing failures result. These failures immediately made it obvious that it was necessary to provide a separator material which would operate against steel at these high speeds with very scanty lubrication for a period long enough to carry the bearing through its initial acceleration during starting.

Dr. Wilcock and General Electric are certainly to be highly complimented for the very quick and thorough method they used to solve this difficult problem. Their tests show that silver plate on the brass separator provides a very satisfactory solution. The silver plated separator, as shown in table II, runs about 77 times as well as the bare brass.

We believe that further improvement can be gained by making the separator of a better bearing bronze, also silver plated. This will provide a further margin of safety because even though the silver plate wears off in spots, the bronze will not transfer to the steel, causing subsequent welding and seizure of the separator. Further research is being carried on to improve the separator material, and it is indicated that bearings can be successfully developed that will withstand numerous dry-starts without failure.

The aircraft turbine builders have also developed better technique for providing lubrication to the bearing during the acceleration period. Both of these developments have been greatly facilitated by Dr. Wilcock and Mr. Frederick Jones' work at the Thomson Laboratory of General Electric Company.

NEW PRODUCTS and EQUIPMENT



VISUAL OILERS AVAILABLE

An 8-page Booklet featuring the latest line of Gits Visual Oilers. Included are endorsements from equipment manufacturers and maintenance engineers on specific applications, complete with photographs and diagrams. Examples show gravity feed, wick feed, constant level, vibrating rod and multiple oilers. Detailed catalog information on every oiler, picture, stock number, capacity, thread, dimensions and prices. Gits Bros. Mfg. Co., 1846 South Kilbourn Avenue, Chicago 23, Illinois.

AEROLUBE

An all-chemical additive for crankcase lubricants has been announced by American Cyanamid Company. This new product, which is designated AEROLUBE 70, is the result of several years development work directed toward filling a much needed requirement of the petroleum industry.

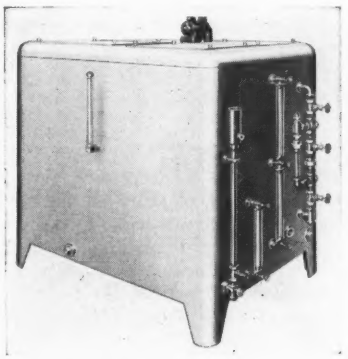
The company lists a number of advantages and economies available to refiners and blenders of motor oils when AEROLUBE 70 is used. Among these are:

1. It is an excellent oxidation and bearing corrosion inhibitor.
2. It is a uniform, high quality, all-chemical additive and thus permits closer manufacturing control of the finished motor oil.
3. Light in color and with a pleasant odor, it is characterized by complete solubility in oil, stability and compatibility with other additives.
4. Being 100% active ingredient, it is not necessary for the user to purchase the diluent oil found in conventional additives.
5. It requires a minimum amount of storage space, thus releasing tankage for other products.

Further information on AEROLUBE 70 may be obtained from the Petroleum Chemicals Department, American Cyanamid Company, 30 Rockefeller Plaza, New York, 20, N.Y.

OIL CONDITIONER

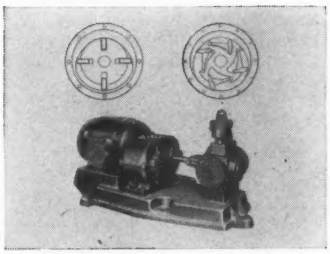
A newly designed conditioner for turbine or other low viscosity, high demulsibility oils which contain rust or oxidation inhibitors has been added to the Bowser line of liquid control equipment, according to an announcement by T. R. Schannen, Manager, Lubrication and Filtration Division, Bowser, Inc., Fort Wayne, Ind.



Made in four sizes to serve steam turbines in all sizes from 1000 KW to 110,000 KW, solid particles as small as 20 microns in size—which act as catalysts and hasten oil deterioration—are said to be effectively removed in the first step of the process. The second step provides filtration for the removal of particles down to one micron in size as well as moisture or vapor cloud. This is claimed to assure dry, crystal clear oil. "Free water" is precipitated and ejected with an automatic device.

With no internal moving parts to cause agitation, there is no turbulence or aeration. Metallic contact is said to be prevented by a baked-on, preventive sealer. Rust and oxidation inhibitors are not disturbed.

The new units are already in production.



ROTARY PUMPS

A greater range in the types of materials that can be handled by the complete line of rotary pumps manufactured by Blackmer Pump Company is now possible with the addition of a "sliding" vane type to their standard "bucket" or "swinging" vane type, as announced by B. L. Gordon, president.

Extremely viscous liquids up to 100,000 SSU are said to be successfully pumped with the new sliding vane type. Vanes are positively actuated by push rods through the rotor and shaft.

Gasoline and other volatile liquids can be pumped more efficiently and at higher lifts with the new "sliding" vane type, it is claimed.

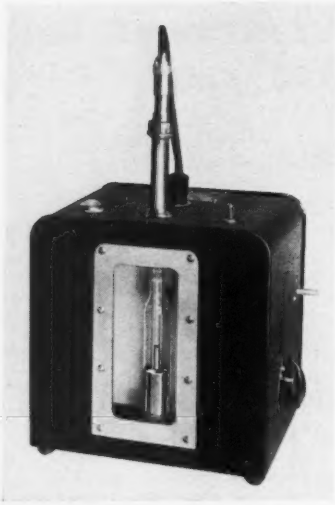
"Sliding" vanes can be furnished in a sound-deadening, nonmetallic material in most instances, which are claimed to be relatively more quiet and wear resistant than conventional metal vanes.

Both "sliding" vanes and "swinging" vanes are said to be self-adjusting for wear and are replaceable without disturbing piping or drive, according to the manufacturer.

Additional design and operating data are available in a new bulletin "FACTS ABOUT ROTARY PUMPS" available from Blackmer Pump Company, Grand Rapids, Mich.

TRICO BROADSIDE

Broadside No. 300-A shows thirteen ways to step up production and cut maintenance cost. A complete condensed catalog in attractive orange and black describes in detail TRICO Fuses, Fuse Clip Clamps, Test Clamps, Fuse Pullers, Lubrication Devices, etc. Free copy is available from TRICO FUSE MFG. CO., 2948 North 5th Street; Milwaukee 12, Wisconsin.



MICRO-SET MANOSTAT

The Precision Scientific Co., 3737 W. Cortland, St., Chicago 47, Ill., announces the development of the Micro-Set Manostat, for regulating and holding a constant vacuum. Its most intensive application will be found in the Petroleum, Organic Chemical and similar industries for vacuum distillation.

The apparatus is installed between a vacuum pump and a distillation system. It operates on a principle of controlled leaks to atmosphere. Excess vacuum is leaked constantly, if necessary, through one end of a double glass stopcock. Leakage at the other end of the stopcock is controlled through a Micro-Set platinum-to-mercury regulator which actuates a solenoid (through a relay) to open or close a leak as needed.

The Micro-Set Manostat has a control sensitivity of better than 0.05 mm Hg. and it operates from atmospheric to absolute vacuum. Within any 100 mm range, the Micro-Set regulator is the only adjustment used. Glass parts are fitted with ground glass connections. To promote accurate operation, the entire unit is enclosed in a dust proof housing.

Also available from this company is their new Petroleum Testing Apparatus Catalog No. 705NR. The 104 page book contains the most advanced test apparatus for Asphalt, Gas, Gasoline, Grease, and Lubricants. In addition, a complete listing of petroleum testing utilities such as Baths, Combustion Apparatus, Distillation Units, High Pressure Equipment, Samplers and Thermometers are included. Catalogs will be mailed to those requesting Catalog 705NR.

LUBRICATION DECALS

On the proven theory that "one picture is worth 10,000 words," Wright & Halperin Inc., have set up a series of cartoonized decals covering Preventive Maintenance in the plant care, lubrication, good housekeeping and safety fields. The copy has been developed with information obtained from lubrication and safety engineers and from the work this firm has done in the safety field for various firms and safety groups throughout the country.

The decals are in brilliant colors for easy readability, the copy is simple and pointed and the cartoons complete the story in a quick glance. Placed strategically throughout the shop and on machines these decals will repeatedly stress Preventive Maintenance, Safety, and Good Housekeeping.

The decals can be applied to almost all surfaces. They are currently available in a very convenient size, 3½" x 2", and can upon request be made in two other sizes, 7" x 4" and 10½" x 6".

The catalogue for the P.M. series is available on request.

For further information write to this Publication or Wright & Halperin Inc., 30 N. La Salle, Chicago 2, Illinois.

FIRE EXTINGUISHER

The C-O-Two Fire Equipment Company of Newark, N. J., has just completed development of their newest contribution to modern fire fighting . . . the C-O-Two Dry Chemical Type Fire Extinguisher.

Tests, tests and more tests, changes, improvements, simplifications . . . now the new C-O-Two Dry Chemical Type Fire Extinguisher is ready.

Self-contained unit . . . no extra gadgets protruding or complicated operating instructions . . . a real down-to-earth fire extinguisher that does a highly efficient job.

Two convenient sizes to fit your fire fighting needs . . . 20 pound capacity and 30 pound capacity . . . both engineered for fast, positive action the instant fire strikes.

Approved . . . Underwriters' Laboratories, Inc., rating is B-1, C-1. C-O-Two Dry Chemical is non-conducting, non-corrosive, non-freezing and non-toxic . . . highly effective on flammable liquid and electrical fires.

On-the-spot recharging . . . no special tools needed.

Complete information and literature, without cost or obligation, can be obtained by writing to the C-O-Two Fire Equipment Company, P. O. Box 390, Newark 1, New Jersey.

CHEK-CHART

Chek-Chart estimates that the present market of automatic transmission fluids for General Motors cars, now open to all oil companies who qualify under a GM plan, is approximately 1,872,885 gallons per year, based on a standard 15,000 mile drain recommendation and the number of units produced up to April of this year.

* * *

Lincoln-Mercury is now providing fittings on the housing of the clutch to lubricate the clutch release shaft on 1949 models. Shafts are being reworked and fittings installed where binding is being experienced. New production will include the fittings. Lubrication diagrams should be marked to show the change.

* * *

Ford Motor Company has issued a statement on the crankcase capacity for its 1949 cars, both 6 and 8-cylinder models. Four quarts is the capacity. Five quarts should only be added when a new filter element is installed.

* * *

Lincoln and Mercury have approved the use of 5W Motor Oil in extreme winter weather conditions and under certain limitations.

* * *

Packard has annouced that lubrication requirements for its new Ultramatic Drive include: 12 quart capacity; drain interval, 10,000 miles; and check interval, every 1000 miles. At present, Packard wants all servicing performed by its dealers.

(*Continued on page* 195)

CURRENT LITERATURE

Amer. Chem. Soc. Division of Colloidal Chemistry. Meeting, San Francisco, California, March 27-April 1, 1949

CONDENSATION PRODUCTS OF FATTY ACIDS WITH ALKYL-OLAMINES AS SURFACE-ACTIVE AGENTS
Valko, E. I.—pp. 9F-10F

The condensation products of fatty acids with alkylolamines were introduced as surface active agents about 15 years ago. Experiments carried out recently indicate that such wetting agents and detergents as the condensation products of diethanolamine with the fatty acids of coconut oil should be classified as "enhanced" soaps rather than as nonionic detergents, the presence of minor amounts of soap being essential. The condensation products are unique among the enhanced soaps in that the amount of insoluble enhancing agent present is several times the amount of soluble soap. The products also represent an extreme example of the phenomenon of solubilization by surface active agents, one mole of the alkylolamine salt of the fatty acid solubilizing several moles of the amide.

ADSORPTION NOMENCLATURE
Lloyd, L. E.—pp. 13F-14F

More than a dozen terms have been used in chemical literature to indicate adsorption phenomenon. Confusion results when authors use the same term for different adsorption phenomena or different terms for the same thing. Adsorption terminology should be consistent with the types of bonding forces involved. Fifteen definitions which meet this requirement are given and discussed.

ADSORPTION OF POLAR ORGANIC COMPOUNDS ON STEEL
Hackerman, N., and Cook, E. L.—pp. 14F-15F

DUAL ADSORPTION OF POLAR ORGANIC COMPOUNDS ON STEEL
Cook, E. L., and Hackerman, N.—p. 15F

First paper. The adsorption of fatty acids, amines, alcohols, and certain methyl, ethyl, and butyl esters of fatty acids on steel has been measured. Chain lengths of the compounds varied from 6 to 18 carbon atoms. The results indicated that a large portion of the adsorption was of a polylayer type, possibly due to surface geometry factors, or in some cases to adsorption of dimer particles from solution. Second paper. Studies on the adsorption of polar organic compounds from benzene solution on steel powder showed that some of the adsorbed component could not be desorbed by repeated washings with benzene. Adsorption of octadecyl amine and adsorption of octadecyl alcohol on steel are discussed.

Analytical Chemistry, Vol. 21, No. 4, April, 1949

PYCNOMETERS FOR OILS
Lipkin, M. R., Mills, I. V., Martin, C. C., and Harvey, W. T.—pp. 504-507

Two designs of pycnometers for the determination of density of oils are discussed. The cup type is particularly suitable for density measurement at a series of temperatures. The side-arm type which fills automatically by siphoning, is advantageous for waxy and extremely viscous stocks.

ASTM Bulletin, No. 158, May, 1949

EXTENSIVE TECHNICAL PROGRAM AT PACIFIC AREA NATIONAL MEETING
Anon.—pp. 20-21

An extensive program, involving 15 technical sessions with approximately 70 papers, has been planned for the Society's first Pacific Area National Meeting scheduled for San Francisco during the week of October 10, 1949. Technical program is presented and a list of the various committees and their chairmen is given.

Butane-Propane News, Vol. 11, No. 5, May, 1949

NEVER RELAX SAFETY VIGILANCE. PART I
Taylor, F. M.—pp. 42-48

The first part of this article deals with the liquefied petroleum gas from the standpoint of its safety. Characteristics of the fuel, special equipment and careful handling make this fuel safer than any other fuel. The article will be concluded July, 1949.

ENGINE WEAR CAUSES OF CRANKCASE OIL DILUTION
Goss, H. P.—pp. 128-130, 132, 134

A checking of operating records of a number of fleets operating under various conditions and on all available types of fuel reveals the fact that engines operating on liquefied petroleum gas consistently show longer life, lower rate of wear and lower maintenance cost than with any other fuel. Factors affecting wear, and the advantages presented by the combustion of liquefied petroleum gas are indicated.

Chemical Abstracts, Vol. 43, No. 6, March 25, 1949

CAPILLARY VISCOMETER
Grover, D. W., and Wertheim, R. A. P.—p. 2044
(Research (London) Vol. 1, Suppl. 1948, pp. 618-24)

NEW FORM OF VISCOMETER FOR TRANSPARENT VISCOUS LIQUIDS
Elkarim, A. A.—p. 2044
(Rev. Sci. Instruments, Vol. 19, 1948, pp. 833-4)

The first article describes a viscometer developed for studying the flow characteristics of a liquid (bentonite dispersion) whose rheological properties are changing slowly with time. The second article describes a new form of viscometer for transparent viscous liquids. The coefficient of viscosity of a transparent viscous liquid can be measured by determining the terminal velocity of a bubble of air evolved into the bottom of a glass cylinder containing the liquid.

OXIDATION OF PARAFFIN OIL BY OXYGEN IN THE PRESENCE OF CERTAIN AGENTS
Arditti, G.—pp. 2410-11
(Groupement franc. develop. recherches aeronaut. Note tech. No. 10, 1943, 36 pp.)

Colorless commercial paraffin oil completely saturated and free from sulfur, was returned with soda to remove acids. The air or oxygen was passed at a measured rate through a volume of the oil in a glass bubbling vessel. Changes were observed in color, density and viscosity of the oil and a soda solution. The oil was oxidized more slowly at lower temperatures and remained unchanged at 85°C. Pressure had little effect. Products of oxidation included carbon dioxide, carbon monoxide, hydrogen, methane, peroxides, organic acids, aldehydes, ketones, esters and small amounts of unsaturated compounds but no alcohols. Oxidation of the oil was hastened by the presence of: copper, iron, nickel, zinc, platinum, lead, nickel oxide, copper oxide, silver oxide, anthraquinone, hexadecanol, acids of 12-18 carbon atoms, or already oxidized oil. Oxidation was retarded by aluminum, silver, ferric oxide, carbon, sulfur, water, phenol, aniline or hexadecane. A bibliography with 66 references is included.

KNOCK IN INTERNAL-COMBUSTION ENGINES
Wheeler, R. W., Downs, D., and Walsh, A. D.—p. 2411
(Nature, Vol. 162, 1948, pp. 893-4)

THE OXIDATION, IGNITION, AND DETONATION OF FUEL VAPORS AND GASES. VI. THE PREVENTION OF PREIGNITION AND DETONATION IN GAS ENGINES. VII. THE OXIDATION OF PENTANE IN VARYING CONCENTRATION IN AIR AT TEMPERATURES RISING TO 700°C AND THE EFFECT OF IRON CARBONYL ON REACTION VELOCITY
King, R. O., Wallace, W. A., Mahapatra, B.—pp. 2411-12
(Can. J. Research, Vol. 26F, 1948, pp. 366-73, 426-40)

Determinations were made of the peroxide and aldehydes mixed with cracked gasoline. It was found that para-compounds are more antioxidant than ortho- and meta-compounds. It was found that tar distillate from needle-leaved trees was very effective. Effect of degree of purity of the gasoline is considered.

DESTRUCTIVE HYDROGENATION OF SYNTHETIC PETROLEUM. I. EFFECT OF CATALYST. II. EFFECT OF REACTION CONDITIONS
Takenaka, Y.—p. 2415
(J. Soc. Chem. Ind. Japan, Vol. 46, 1943, pp. 658-62)

Kogasin oil was fractionated into 3 portions (100-200°, 200-300°, and above 300°C). Each portion was hydrogenated 5 minutes in a rocking autoclave at 480°C with 20% nickel oxide, molybdenum oxide, molybdenum sulfide or molybdenum phosphate with or without kieselguhr as catalyst and hydrogen under 35 atmospheres initial pressure to yield gasoline. Effect of varying the catalyst was studied and effect of reaction condition is taken up.

POISONING BY GASOLINE CONTAINING TETRAETHYLLEAD
Paterson, E. V., and Bollea. G.—p. 2416
(Riv. med. aeronaut, Vol. 10, 1947, pp. 324-35)

A critical review with 23 references is given.

LUBRICATING OIL. I. DEPRESSION OF THE POUR POINT OF MINERAL LUBRICATING OIL BY THE ADDITION OF FATTY ACIDS AND THEIR ESTERS. II. INFLUENCE OF ADDING METALLIC SOAPS OF FATTY ACIDS ON ADHESIVENESS AND POUR POINT OF MINERAL LUBRICATING OIL
Ueno, S., Ota, Y., Sakaguchi, S., and Yasuda, Y.—p. 2416
(J. Soc. Chem. Ind. Japan, Vol. 46, 1943, pp. 652-7)

Myristic, lauric, and capric acids and their methyl and ethyl esters were added to Ostrich #3 (pour point—7°C) to lower the pour point. High molecular fatty acids were more effective than low molecular weight fatty acids but the opposite is true for esters. Adding calcium, aluminum, magnesium, barium, zinc, lead, and tin soaps of capric, lauric, myristic, palmitic and stearic acids on the adhesiveness and pour point of mobile oil was studied. Of soaps of

any one metal, fatty acids of higher molecular weight caused greater adhesiveness and tin was the highest.

SYNTHESIS OF LUBRICATING OIL. I. LUBRICATING OIL PREPARED FROM POLYMERIZED METHYL ESTERS OF FATTY ACIDS
Ueno and Matsuda, S.—p. 2416
(J. Soc. Chem. Ind. Japan, Vol. 46, 1943, p. 657)

SYNTHETIC LUBRICATING OIL. I. LUBRICATING OIL BY HYDROGENATION OF THE CONDENSATION PRODUCT OF CHLORINATED PARAFFIN WAX AND BENZENE. II. MEAN MOLECULAR STRUCTURE OF THE AVIATION LUBRICATING OIL PREPARED BY THE CONDENSATION OF CHLORINATED PARAFFIN WAX AND BENZENE
Tanaka, Y., Kobayashi, R., Onoguchi, S., and Hara, Y.
(J. Soc. Chem. Ind. Japan, Vol. 44, 1941, pp. 1019-23, Vol. 45, 1942, pp. 319-22)

Methyl esters of highly unsaturated fatty acids from bonito oil were polymerized by heating 5 hours at 300°C in presence of zinc chloride or aluminum chloride in a current of carbon dioxide and the product was hydrogenated at 370°C under pressure with ferric oxide as catalyst to get hydrocarbons. When low boiling fraction was removed the residual oil was a good lubricant. Chlorinated paraffin wax was treated 10 hours at 90-100°C with equal amount of benzene by adding 4-20% catalyst (equal weight of aluminum chloride and active clay). The second part takes up the mean molecular structure of lubricating oils prepared from condensation of chlorinated paraffin wax and benzene by the Friedel-Crafts reaction. The oils correspond to the formulas $C_{24}H_{40}$-$C_{60}H_{96}$.

RELATIONS BETWEEN THE AMOUNTS OF SULFURIC ACID USED AND THE PROPERTIES OF THE REFINED PETROLEUM LUBRICATING OIL. I. ACID REFINING OF LUBRICATING OIL. II. INFLUENCE OF THE AMOUNT OF THE ACID USED ON THE GENERAL PROPERTIES OF REFINED OIL. III. DEGREE OF REFINING AND STABILITY. IV. MEAN MOLECULAR WEIGHT AND GENERAL FORMULA OF REFINED OIL AND DISTRIBUTION OF SULFUR, NITROGEN, AND OZYGEN. V. SPECIAL RING ANALYSIS OF REFINED OIL. VI. OILINESS OF REFINED OIL.
Kurosawa, T.—p. 2417
(J. Soc. Chem. Ind. Japan, Vol. 46, 1943, pp. 391-401, 545-548)

Japanese crude lubricating oil was refined with sulfuric acid. Properties of the raffinate are considered.

SYNTHESIS OF MINERAL OILS. II. PREPARATION OF COLD-WEATHER-PROOF MOBILE OIL FROM FUSHUN SHALE LIGHT OIL ON A SEMI-INDUSTRIAL SCALE. III. EXAMINATION OF THE HOPPLER VISCOMETER. IV. RING ANALYSIS OF MOBILE OILS FOR WINTER USE. V. RELATION BETWEEN THE COMPOSITION AND THE VISCOSITY INDEX OF MOBILE OILS FOR WINTER USE
Morikawa, I., Takashima, S., Abe, N., and Kato, K.—pp. 2418-19
(J. Soc. Chem. Ind. Japan, Vol. 45, 1942, pp. 881-91)

Vol. 43, No. 8, April 25, 1949

A NEW FALLING BODY VISCOMETER FOR PRESSURES UP TO 2000 ATMOSPHERES
Kuss, E.—p. 2821
(Naturwissenschaften, Vol. 33, pp. 312-14 (1946)

A viscometer is described with a spherical body closely fitting in a 16 mm. glass tube with magnetic means to raise the sphere.

VISCOSITY OF LIQUIDS AND TEMPERATURE
Banerji, B. K.—p. 2835
(Current Sci. (India), Vol. 17, pp. 214-15, 1948)
KINETIC THEORY FOR THE VISCOSITY OF AMORPHOUS SUBSTANCES
Kochendorfer, Albert—p. 2835
(Z. Naturforsch, Vol. 3a, pp. 329-40, 1948)
VISCOSITY-VOLUME RELATION FOR ETHER
Jobling, A.—p. 2835
(Nature, Vol. 162, p. 620, 1948)

These 3 articles deal with viscosity of liquids and amorphous substances and the viscosity-volume relation for ether.

ACTION OF ORGANIC INHIBITORS IN THE ACID ATTACK OF MILD STEEL
Hoar, T. P.—p. 2917
(Pittsburgh Intern. Conf. on Surface Reactions, 1948, pp. 127-34)

The author takes up the use of inhibitors to prevent attack of steel by acid. The following inhibitors were studied: aniline, diethylaniline, para-phenylenediamine, 2-naphthylamine, phenyl-2-naphthylamine, pyridine, quinoline, alpha (and beta)-naphthoquinoline, 2, 4 (and 2, 6)-dimethylquinoline, ethylquinolinium bromide, acridine, Acridine Orange, Acridine Red, acriflavine, euflavine, proflavine, petroleum sulfonates, sulfonated castor oil, and some commercial inhibitors.

OXIDATION REACTIONS OF METHANE
Meunier, J.—p. 2923
(Chimie Industrie, Vol. 60, pp. 550-8, 1948)

Methane oxidation and stoichiometry of the reactions are discussed. A molecular diagram of the Gibbs triangle type permits a graphic representation easier to read and of wider application than previous methods.

MODERN INDUSTRIAL SOLVENTS
Woodhead, A. H.—p. 3118
(Paint Manuf., Vol. 19, pp. 46-9, 1949)

Large-scale production of solvents is due to a desire to use a primary waste organic product, a demand for a particular solvent known only on a laboratory shelf or a demand for a solvent to satisfy requirements associated with the solution and application of scientific substances. One group of solvents illustrating each principle includes: furans, derivatives of cycloparaffins, and solvents from glycols.

FEEDING THE STILLS WITH SUPERHEATED VAPORS OF THE CRUDE OIL
Volokh, S. M.—p. 3178
(Azerbaidzhanskoe Neftyanoe Khoz., Vol. 26, No. 6, pp. 16-20, 1947)

Material and heat balances are calculated for columns fed with superheated vapors. The use of superheated vapors is practicable when provisions are made for stripping the reflux just above the feed plate.

BREAKING OF OIL EMULSIONS WITH SYNTHETIC DETERGENTS.
Lawrence, A. S. C.—p. 3178
(Chemistry & Industry, Vol. 39, pp. 615-17, 1948)

Breaking fuel oil-sea water emulsions is discussed in terms of collision frequency, sedimentation velocity and viscosity changes.

TECHNOLOGY OF THE SYNTHESIS OF FILM-FORMING ESTER DERIVATIVES FORMED BY HIGH-TEMPERATURE KEROSENE OXIDATION
Tsvskovskii, V. K.—p. 3181
(Zhur. Priklad. Khim. (J. Applied Chem.), Vol. 20, pp. 277-82, 1947)

The oxidation period, depending on the nature of the raw material is 3 to 8 hours. Kerosene does not polymerize during this interval and viscosity of reaction mass is not much higher than that of kerosene. Reaction temperature is 160 to 170° C; much kerosene is carried over even when its boiling point is much higher than that.

OXIDATION TEST OF MINERAL OILS
Stejina, Vaclav—p. 3182
(Chem. Obzor, Vol. 23, pp. 207-9, 1948)

Attention should be paid to changes of mineral oil during oxidation test, as characteristic values determined at the end of the oxidation test do not give the true picture of resistance of the oil to oxidation. Acid values determined by potentiometric titration in short periods are recommended.

STUDY OF THE FILTRATION PROCESS IN PURIFICATION OF LUBRICATING OILS WITH CLAYS
Gandyurina, A. I.—p. 3182
(Azerbaidzhanskoe Neftyanoe Khoz., Vol. 26, No. 5, pp. 21-3, 1947)

THE CHEMICAL-PHYSICAL TREATMENT AND REUTILIZATION OF USED EMULSION LUBRICANTS
Doring, Ernst—p. 3183
(Erdol u. Kohle, Vol. 1, pp. 285-7, 1948)

Emulsions of water in oil that are very stable can be broken by adding 0.1-0.3% wetting agent and 0.1% sodium carbonate for each 10% water content, heating to 140° C for ½ to 2 hours and letting stand for 24 to 48 hours. Most impurities remain in the water phase.

MODERN CRITERIA OF THE EVALUATION OF LUBRICATING OILS FROM THEIR VISCOSITY-TEMPERATURE BEHAVIOR
Girelli, A.—p. 3183
(Riv. compustibili, Vol. 2, pp. 103-14, 1948)

A review of the calculation of the index of viscosity in reference to temperature is given.

DEVELOPMENT OF THE FAT INDUSTRY IN THE LAST 75 YEARS
Kunzman, Th.—p. 3215
(Seifen-Ole-Fette-Wachse, Vol. 75, pp. 9-12, 1949)

REMARKS ON AUTOCLAVE SPLITTING (OF FATS)
Ditrich, Rudolf—p. 3215
(Seifen-Ole-Fette-Wachse, Vol. 74, pp. 301-2, 1948)

THE NEWEST TECHNICAL DEVELOPMENT IN THE PRODUCTION OF SOAPS FROM OXIDATION PRODUCTS OF HYDROCARBONS.
van der Werth, A.—p. 3218
(Seifen-Ole-Fette-Wachse, Vol. 74, pp. 299-301, 320-2, 1948

A review is given with 20 references.

Chemical and Engineering News, Vol. 27, No. 19, May 9, 1949

NEW RESEARCH LABORATORY
Anon.—p. 1368

The dedication of the new automotive research laboratory of the American Oil Co. and its associate firm, the Pan American Refining Co., is reported. The dedication took place on April 27-28, at Baltimore, Md. The feature of the new laboratory is a chassis dynamometer which can duplicate in the laboratory every condition encountered on the road. Other equipment of the laboratory is mentioned.

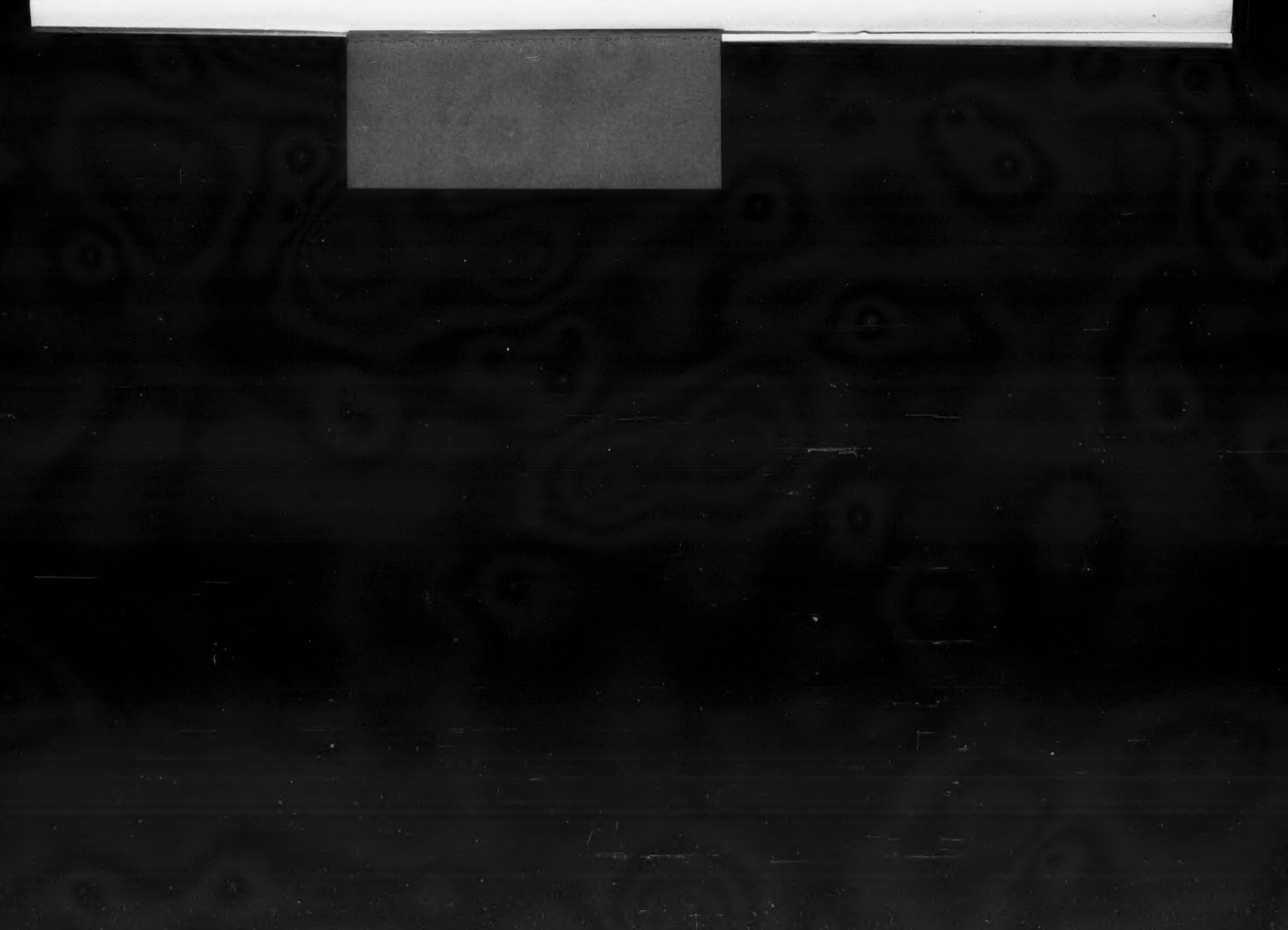
SILICONE INSULATING RESIN
Anon.—p. 1399

A silicone insulating resin designed to enable electrical equipment to operate at temperatures as high as 180°C. has been announced by General Electric Co. Designated G-E silicone resin 9989-1, the tough thermosetting insulation has general application for impregnating spun glass and asbestos wire coverings and for binding coils, windings, and other motor, generator and transformer parts. The resin is claimed to have excellent dielectric strength as well as superior heat and water resistance.

CORROSION PREVENTION
Anon.—p. 1399

W. H. and L. D. Betz has recently developed a new product for the prevention of corrosion under the name of Corrogen, which is catalyzed sodium sulfite. Specific examples of the use of Corrogen are: prevention of corrosion in hot and cold water distribution lines, removal of oxygen prior to hot water generators, corrosion protection in compressors, Diesel engines, and other specific pieces of equipment, and prevention of corrosion in feed lines and economizers.

(*Continued on page* 192)



NEWS OF THE SECTIONS

BOARD OF DIRECTORS APPROVES NEW GRADE OF MEMBERSHIP

Student Members—$4.00

Student Members shall be: persons registered in accredited engineering colleges who are studying for an engineering degree. Such students shall be entitled to receive the Society Journal, have access to all other Society publications at regular membership prices, and carry full membership privileges, with the exception of voting rights.

BOSTON

New Officers were elected for this Section at their May meeting. (See Section Officers' page). In its first year of Section activity, it has been clearly demonstrated that Boston and adjoining territories are deeply interested in the overall subject of lubrication. We predict a healthy future for this Section, and our congratulations to its past and present Officers.

BUFFALO

Another International night was enjoyed by the Buffalo Section in May. The meeting was held under the direction of Canadian Co-Chairman, Mr. George T. Wright. The speaker of the evening was Dr. George H. Von Fuchs, formerly with Shell Oil Company in their Research Division, lately entered upon the consulting field, with his office in Niagara Falls, New York, and recently affiliated with the Buffalo Section. His subject covered Inhibited Turbine and Transformer Oils, and his interesting presentation was accompanied with slides tracing the developments from the construction of the first transformer in Germany and the first in the United States a year later, up to the latest improvements in inhibited oils for servicing the equipment. Dr. Von Fuchs has been associated with our new President, Mr. Charles L. Pope, on the Turbine Oil Committee of A.S.T.M., and he gave an interesting account of the work of that Committee.

The June meeting was held at the Buffalo Automobile Club in Clarence, New York. It was a very pleasant afternoon and evening devoted to fun and good fellowship under the Chairmanship of Herbert Roosa, assisted by Tom O'Rourke, John Wallace and Bob Meyers, who did everything possible to make it a day long to be remembered by the 60 members and guests present. The weather was ideal, and multi-colored hats of rather Chinese design lent color to the affair during a softball game, sports program, and refreshment and chinfest. Tom O'Rourke and Charlie Pope chose sides for the game but Tom deserted to become umpire so Pope's cohorts outscored the orphans. The sports included walking races, egg throwing, ping-pong ball into barrel toss, horseshoe pitching, and golf chipping contest. All were hotly contested and provided many good laughs. An excellent supper served in the club house was accompanied by singing familiar songs and accordion playing. One small item of business had to be transacted by Chairman Jim Farry who then conducted a drawing for door prizes, which were won by Walt Peuchen, Bill Millett, and Aubrey Brownell.

Presentations by Chairman Farry to Mr. Charles L. Pope, National President: a pen and pencil set; to Thomas Marshall, incoming Society Director: a wallet; and to Mr. W. Ted Everitt, retiring Society Director: a wallet—as tokens of the esteem in which they are held by their Section, and appreciation for the work they are doing.

A vote of thanks to Tom and his Committee and those who contributed for the prizes. Nate Morrell, Secretary of the Buffalo Section, is to be commended for his able job of reporting on this Section's activities.

CHICAGO

At the last regular meeting of the 1948-49 season, the speaker of the evening was Mr. Melville Ehrlich, Chief Chemist of American Lubricants, Inc., Buffalo, New York, who discussed the important subject of grease. Mr. Ehrlich's talk was fundamental and down to earth, and in language which the layman could not help but understand, he explained what greases are, how they are made, and the correct usage and limitations of each type commonly used by industry today. Mr. Ehrlich's interesting coverage of his subject provoked a considerable amount of lively discussion.

The Officers and Directors of the National Association are deeply grateful to the Chicago Section for their generous contribution to our Bearing Project fund, which was announced by the retiring Chairman Carl E. Schmitz. Such visible, tangible support from within our Society demonstrates beyond a question the feasibility and success of our project.

The annual golf outing of this Section was held at the Mt. Prospect Country Club in June, and we are indebted to the new Secretary, Mr. Fred J. Sealy of the Hodson Corp. for acting as pinch-hitting reporter of their very successful affair. "Our thanks to Co-Chairman Bill Youngclaus and Joe Slomer for the fine weather and a lot of fun. The local suppliers furnished many excellent prizes, and the attendance established another new record for this Section. Bill Leonard and Jim Ehret, with their unequalled tenors, led the group singing. Joe Slomer's cigarette and imitation acts were classified as professional. It took a snappy low gross of 77 by Jack Mace to establish a new champion. Al Paul, the perennial winner, was second with an 80. Fred Sealy placed with an 82. Bob Kraus, Chairman of the Chicago Section, wishes to thank the Golf Committee and the various suppliers, for the splendid cooperation that made this party such a great success."

CONNECTICUT

New Officers were elected at the last meeting of this Section. (See Section Officers' page). This group is to be congratulated on the fine progress made in its first year since organization. We feel sure that when activities again begin in the fall, this Section will continue to grow on the basis of its past and present able leadership.

(*Continued on page* 191)

A.S.L.E. Section Officers

Baltimore:
Chair., A. E. Cichelli, Bethlehem Steel Company, *802 E Street, Sparrows Point 19, Md.
V. Chair., P. Raymond Staines, The Davison Chemical Corp., Curtis Bay Plant, Baltimore 3, Md.
Secy.-Treas., W. C. Eichelberger, American Oil Company, *3054 Mayfield Ave., Baltimore 13, Md.

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Secy., R. B. Lewis, Shell Oil Co., Inc., 441 Stuart St., Boston 16, Mass.
Treas., E. M. Higgins, Master Lubricants Co., *98 Lovell Road, Watertown, Mass.

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Co-Chair. (Canada), G. T. Wright, Dominion Foundries & Steel, Ltd., Depew St., Hamilton, Ontario, Canada.
Secy., N. C. Morrell, Eastman Kodak Co., 333 State St., Rochester 4, N. Y.
Treas., G. Findlay, Republic Steel Corp., 1175 S. Park Ave., Buffalo 20, N. Y.

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Secy.-Treas., A. F. Green, Farval Corp., 62 LaSalle Road, Hartford 7, Conn.

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Secy., H. L. Sellers, Shell Oil Co., Inc., 700 N. Euclid Ave., Dayton 7, Ohio.
Treas., V. W. Smith, G. W. Smith & Sons, Inc., 5400 Kemp Road, Dayton 3, Ohio.

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Secy., R. W. Kenyon, L. R. Kerns Co., *2034 N. Highland St., Dearborn, Mich.
Treas., J. W. Swain, Jr., Mergraf Oil Products Co., Inc., P. O. Box 95, Northville, Mich.

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Secy.-Treas., J. S. Michell, Shell Oil Co., *2112 St. Joe Blvd., Fort Wayne, Indiana.

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Secy.-Treas., J. E. Burns, Jr., Crescent Oil Co., 514 W. Wyoming St., Indianapolis 2, Ind.

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V. Chair., Richard D. Bussard, Ladish Co., 5481 S. Packard, Cudahy, Wisc.
Secy., H. P. Hofmeister, Socony-Vacuum Oil Co., *2355 N. 82nd St., Wauwatosa, Wisc.
Treas., Darryl W. Johnson, Standard Oil Co., 414 W. Michigan St., Milwaukee 1, Wisc.

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By-Laws:
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Westinghouse Electric Corp.
Education and Training Program:
D. D. FULLER
Columbia University
Finance:
C. E. SCHMITZ
Crane Packing Co.
Industrial Membership:
W. F. LEONARD
National Office
Membership:
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Bowser, Inc.
New Sections:
REGIONAL VICE PRESIDENTS
with NATIONAL OFFICE
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Westinghouse Electric Corp.
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Co-Chairman, W. H. MILLETT
Linde Air Products Co.
Projects and Publicity:
E. M. KIPP
Aluminum Co. of America
Historian:
W. G. FATCH
Carnegie-Illinois Steel Corp.
(Gary Works)
A.S.L.E.-A.S.M.E. Coordination:
M. E. MERCHANT
Cincinnati Milling Machine Co.

Membership in the Society is in several grades as defined below. Assignment to grade is made by the Admissions Committee or Board of Directors on the basis of information submitted or supplied by references.

MEMBERS—$12.50

Members shall be: (1) persons not less than twenty-four years in age who are engaged in research and instruction at technical schools, universities and various publicly and privately supported institutions in the field of lubrication; or (2) persons not less than twenty-four years in age who have occupied recognized positions as Lubrication Engineers for a period of three or more (not necessarily consecutive) years prior to date of admission, involving the responsibility for or supervision of the development, selection, field use and application of lubricants as differentiated from other activities; or (3) persons not less than twenty-four years in age who are indirectly concerned with the field of lubrication, but possessing other qualifications of experience, knowledge and accomplishment, have manifested a particular interest in the purposes and welfare of the Society, to the extent that their membership would be a valuable contribution to the successful functioning of its activities.

JUNIOR MEMBERS—$6.25

Junior Members shall be: persons less than twenty-four years in age, and those who do not completely fulfill the membership requirements for Members.

INDUSTRIAL MEMBERS

Industrial members are such persons or organizations as may be interested in and desire to contribute to supporting the purposes and activities of the Society. The fees paid by an industrial member in general will not be allowed to exceed $200.00 per year.

New York:	Chair., W. E. Campbell, Bell Telephone Laboratories, Murray Hill, New Jersey V. Chair., Edward H. Erck, Bendix Aviation Corp., Teterboro, New Jersey. Secy., John C. Vangundy, The Texas Co., 135 E. 42nd St., New York 17, N. Y. Treas., Aubrey Setzer, Colgate-Palmolive-Peet Co., *P. O. Box 124, Metuchen, New Jersey
Northern California:	Chair., B. B. Farrington, California Research Corp., P.O. Box 1627, Richmond, Calif. V. Chair., A. S. Horwitz, E. F. Houghton & Co., Quint & Davidson Sts., San Francisco, Calif. Secy-Treas., E. B. Lien, Union Oil Co. of California, 425 First St., San Francisco, Calif.
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Pittsburgh:	Chair., Dr. John Boyd, Westinghouse Electric Corp., Res. Lab., Ardmore Blvd., E. Pittsburgh, Pa. V. Chair., John F. Boal, Carnegie-Illinois Steel Corp., Munhall, Pa. Secy.-Treas., E. S. Reynolds, Socony-Vacuum Oil Co., Inc., *118 Cochran Road, Pittsburgh 16, Pa.
St. Louis:	Chair., T. V. Picraux, Lincoln Engineering Co., 5701 Natural Bridge Ave., St. Louis 20, Mo. V. Chair., O. Wulfert, Wagner Electric Corp., 6400 Plymouth Ave., St. Louis 14, Mo. Secy., L. R. Tharp, E. F. Houghton & Co., Box 1806, Cabanne Station, St. Louis 12, Mo. Treas., J. B. Davis, Monsanto Chemical Co., 1700 S. 2nd St., St. Louis 4, Mo.
Twin Cities:	Chair., E. H. Lindemann, Minneapolis-Honeywell Regulator Co., 2753 4th Ave., South, Minneapolis, Minn. V. Chair., C. K. Olson, Standard Oil Co., *2711 Garfield St., N. E., Minneapolis 18, Minn. Secy.-Treas., J. R. Ritchie, Jr., Ritchie Engineering Co., 3509 Irving Ave., South, Minneapolis 8, Minn.

*Denotes Residence Address Preferred.

News of the Sections

(*Continued from page* 189)

DAYTON

Mr. H. L. Sellers, Secretary, reports as follows: "The Dayton Section met in May, and the new Chairman, Mr. E. M. Glass, was installed. The retiring Chairman, Mr. R. F. McKibben, was presented with a 'Certificate of Appreciation' in recognition of his time and effort given to organize and further the interests of A.S.L.E. Mr. W. F. Leonard, National Secretary, discussed the growth of the Society. He pointed out that the results to date definitely indicate the need for further expansion of the organization.

Mr. C. E. Schmitz, Regional Vice-President, commented on the activities of A.S.L.E., one of the foremost problems being the matter of education on selection and application of lubricants. Representing Chicago, he presented Dayton with a gavel. This award was won in a spring membership contest between the two Sections. Mr. Leonard presented the gavel block as an award from the National Society. Due to the interest shown in this membership drive, it was suggested that this be made an annual event.

The speaker for the evening was Mr. William P. Youngclaus, Alemite Division of Stewart-Warner Corp., Chicago, who spoke on the subject 'Lubrication Engineering Comes of Age.' He reviewed the early history of lubrication engineering. The steel industry started, in 1920, to recognize the need of a lubrication engineer. Then, in 1938, Mr. Charles L. Pope presented a paper on this subject. The lack of trained men, in 1942, was the basis of the formation of A.S.L.E. Columbia University has a course in lubrication engineering. Other colleges have also recognized the need for this type of training and plan to offer same in the near future. He pointed out that A.S.L.E. would continue to grow and be of benefit to industry by:

1. Emphasizing A.S.L.E. to Management.

2. Using modern methods to save man hours.

3. Proper application of lubricants — thus reducing failures frequently traced to faulty lubrication.

4. Proper selection of lubricants.

Mr. Youngclaus concluded by saying that down time is never made up—all is lost. Therefore, the lack of down time is the only solution to lower production costs."

INDIANAPOLIS

Mr. R. G. McMahon, Engineer for the Socony-Vacuum Oil Corp., presented a very interesting discourse on "Automotive Lubrication with Reference to Race Car Requirements." The subject was very timely in that the meeting was held just prior to the big 500-mile automobile race in Indianapolis. Mr. McMahon has spent practically all of his time since the opening of the practice trials for the Indianapolis race at the Speedway, working with the various car owners, mechanics, and drivers. Many of the difficulties encountered by these men in the preparation of their cars for the race were discussed along with the steps taken in the effort to overcome these difficulties. Every 500-mile race brings forth several new innovations, and this year was no exception. The new ideas—in particular the floatless carburetor—were discussed along with the general feasibility of the several new ideas. As an extra added attraction, a special film was shown that high-lighted the important stages of the 500-mile race of 1948. This film was furnished through the courtesy of the Socony-Vacuum Oil Corp., and proved of extreme interest to all present. IMPORTANT NOTICE: The first meeting in the fall will be held the fourth Monday of September.

LOS ANGELES

Mr. H. C. Zweifel spoke at the final spring technical meeting on "The Development of Thread Sealing Lubricants." Mr. Zweifel is in charge of the Grease Research Laboratories, and serves as Technical Advisor to the Grease Manufacturing and Oil Compounding Plant of the Richfield Oil Corp. "After outlining the limitations and shortcomings of the various conventional lubricants used for this purpose, particularly for use on oil casing drill piping where extremely high pressures are encountered, and where seizing and galling of threads are major problems, he proceeded to describe the methods and testing procedures they had used in developing a new product possessing excellent service characteristics. This lubricant called 'Thread Seal,' is a

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petroleum base product compounded with especially prepared copper, lead, and amorphous graphite. It was found to give very satisfactory money-saving results in solving many of their own company's field problems, not only for sealing oil casing threads, but also when used on steam lines up to 500 pounds pressure, high-presure gas lines, and on stud bolts of steam reciprocating type engines, boiler manhole covers, etc. The compound has so many possibilities for the entire oil industry that the company has arranged for its use as the start of one of the new A.P.I. research projects at Mellon Institute.

In the spirited discussion that followed Mr. Zweifel's interesting presentation, Mr. G. French, Manager of Products Research Development for the Richfield Oil Corp., gave further enlightenment on the problem of developing and testing thread sealing lubricants and of the vast savings made by their own company by the use of 'Thread Seal.' "

We thank Mr. Arthur M. Montzheimer, the Field Editor of this Section, for the very fine report quoted above.

PITTSBURGH

At the May meeting, Mr. George L. Sumner, Sr., (1948-49 President of A.S.L.E.) high-lighted the events of the National Convention. Dr. Sigmund Hammer of Gulf Research and Development Company discussed "Geophysical Prospecting for Oil." IMPORTANT NOTICE: The September meeting speaker will be Dr. M. E. Merchant who will talk on the subject of "The Action of Cutting Fluids in Machines."

Current Literature

(*Continued from page* 188)

Vol. 27, No. 20, May 16, 1949

SYRACUSE UNIVERSITY OPENS NEW ENGINEERING AND SCIENCE CAMPUS
Anon.—pp. 1440-1441

The Syracuse University's $10 milliom engineering and science campus was opened April 27, 1949. Engineering college for technological education, including the department of chemical engineering, is described. The Institute of Industrial Research is working in close cooperation with all departments of the college of applied science as well as with other colleges and departments of the Syracuse University.

Vol. 27, No. 21, May 23, 1949

CHEMISTRY OF TOMORROW
Rochow, E. G.—pp. 1510-1515

On May 9, 1949, the author received the Leo Hendrikbackeland Award, a medal "for outstanding achievement in creative chemistry." The text of the address delivered by the author is presented. In this address the picture of the future world is given which lives on "inexhaustible instead of exhaustible raw materials." The formula for a "conservation quotient" is given and discussed. The problem of completing the potassium cycle to supply additional potassium to the soils, and problem of conservation and production of food and of clothing are taken up.

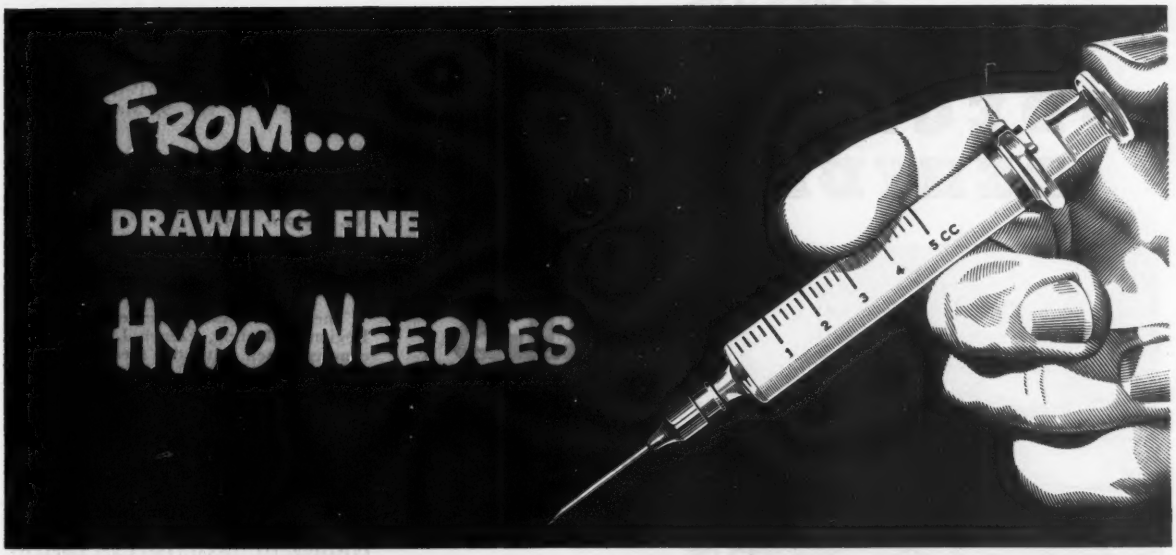
EXPANSION TREND IN DETERGENTS FAVORS INDUSTRIAL TYPES
Anon—p. 1515

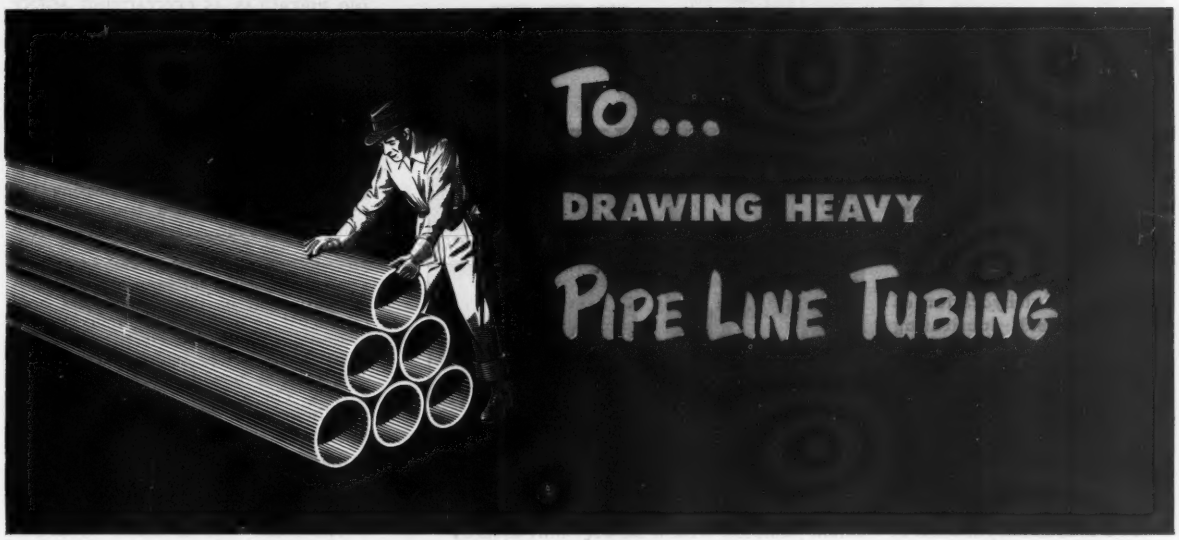
A steady expansion of industrial detergents due to the market research conducted by individual members of the industry is discussed. Statistical data on detergent sales are given. The production of soap, a number of trends in industrial detergents, and the patent situation in industrial detergents are taken up.

BUREAU OF MINES DEDICATES COAL-TO-OIL DEMONSTRATION PLANTS
Anon.—pp. 1520-1521

A new American chemical process industry was proclaimed at the formal dedication of the Bureau of Mines' coal-to-oil demonstration plants. The plants dedicated consist of a 200-to-300-barrel-per-day coal hydrogenation plant and a slightly smaller gas synthesis or Fischer-Tropsch unit. The "coal hydro" unit is now completed and is expected to be in full normal operation before July 1, 1949. The 800-to-1,000-barrel-per-day gas synthesis plant was only partially

(*Continued on page* 194)





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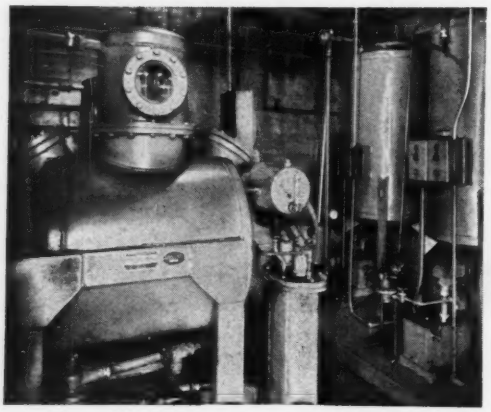

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OILS
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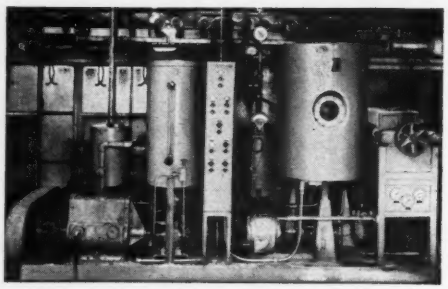

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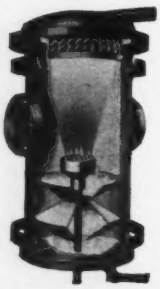

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(*Continued from page* 192)

completed at the time of the dedication. The equipment and processing are touched upon. See also Petroleum Processing, Vol. 4, No. 5, May, 1949, p. 610.

Chemical Engineering Progress, Vol. 45, No. 4, April, 1949

DISTILLATION COLUMN DESIGN FOR PROCESSING POLYMERIZABLE COMPOUNDS
Coulter, K. E.—pp. 227-234

The paper was presented at Ninth Regional Meeting, French Lick, Ind. It concerns itself with the special requirements in design of a distillation column for handling polymerizable compounds. Polymerization rates, column operating conditions, including cleaning, instrumentation involved and addition of inhibitors are taken up. On pp. 232-234 the reader will find the discussion of the paper.

COMMERCIAL DESALTING UNIT EMPLOYING FIBERGLAS AS CONTACTING AGENT
Hayes, J. G., Hays, L. A., and Wood, H. S.—pp. 235-240

The paper was presented at Eighth Regional Meeting, Cleveland, Ohio. A process is described in which relatively fine glass fibres are used as the contacting agent in the solid contact method of desalting crude petroleum. The process consists of (1) washing the crude oil with fresh water, (2) heating the resulting emulsion to a temperature of 200°F. or higher, (3) passing the emulsion through beds of glass fibres to coalesce the emulsified water, and (4) separating the desalted oil from the water. A demonstration of this process has been conducted in a full scale refinery unit processing 10,000 barrels per day of a West Texas crude which carries from 100 to 200 pounds of salt per 1000 barrels. On p. 240 the reader will find the discussion of the paper.

CORRELATION OF OPERATING VARIABLES IN CATALYTIC POLYMERIZATION
Steffens, J. H., Zimmerman, M. U., and Laituri, M. J.—pp. 269-278

The paper was presented at Eighth Regional Meeting, Cleveland, Ohio. A correlation is presented which shows the effect of operating variables upon conversion in catalytic polymerization to produce motor gasoline. This correlation was developed from the results of twenty-five tests run on commercial scale plants. It applies to the polymerization of propylene and butylene streams in tubular-type catalytic polymerization units using copper pyrophosphate catalyst. No relationship could be found between the operating variables and the octane rating of the polymer produced. As reactor temperature is increased, however, an increase in the ASTM 50% and 90% distillation points of the polymer is reported. A chart is given for readily predicting the weight per cent conversion of the olefins in the total feed for a wide range of operating conditions. The average deviation of the predicted conversions from the actual conversions obtained from the twenty-five tests used in developing the correlation is ±2.5 weight %. On p. 278 the reader will find the discussion of the paper.

(*Continued on page* 196)

(*Continued from page* 186)

LINCOLN APPOINTS

Frank M. Goodman, formerly of Skilsaw, Incorporated, has been appointed Sales Promotion Manager of the Industrial Division of Lincoln Engineering Company, St. Louis, manufacturers of a complete line of industrial lubricating equipment and centralized lubricating systems. Mr. Goodman will work with the industrial distributors and promote the sales of Lincoln Industrial Lubricating Equipment. His 16 years with Skilsaw, selling in the Pittsburgh area, managing their Cleveland office, and later as their eastern sales manager will be very valuable in his new connection.

"HIGHER DIOLS"

Uses and properties of eight new glycols are described in a new eight page booklet, "Higher Diols" published this week by Carbide and Carbon Chemicals Corporation. Special glycols described include butanediol-1,3; pentanediol-2,4; the two six-carbon diols, 2-methyl-pentanediol-2,4 and hexanediol-2,5; heptanediol-2,4; ethylhexanediol; and two interesting new substituted 1,5-pentanediols. This booklet gives complete physical properties for the higher diols, comparing them to the lower, more familiar 2- and 3-carbon glycols and glycerol.

The new higher diols readily form diesters which are important as plasticizers, resins and emulsifying agents. A primary hydroxyl group usually is more reactive than a secondary. This difference in reactivity can be used to advantage for the preparation of mixed esters. Dehydration generally yields a diene but in some cases a single unsaturated linkage can be obtained.

Copies of this booklet can be obtained by writing Carbide and Carbon Chemicals Corp., 30 East 42nd St., New York 17, N. Y. and requesting Form 6719.

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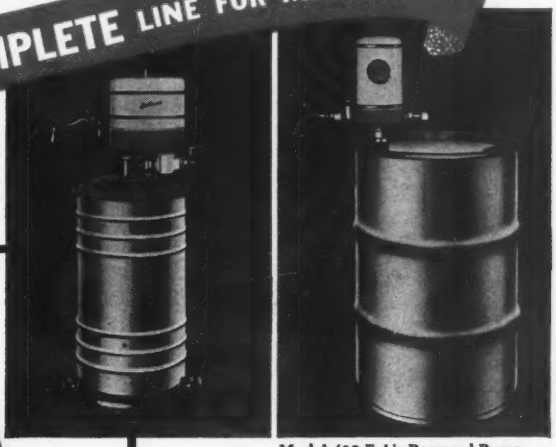

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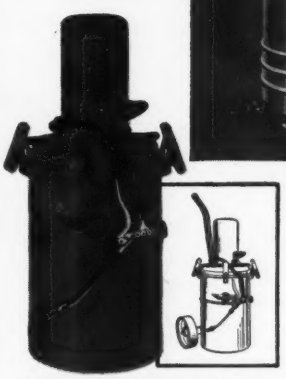

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(*Continued from page* 194)

Chemistry and Industry, No. 16, April 16, 1949

THE SILICONES
Murdoch, K. A.—p. 255

The paper was presented at the Newcastle-upon-Tyne Section of the Society of Chemical Industry, at Sunderland, March 8, 1949. Having traced the development of the silicones from the attempts by Kipping in the early 1900's to make an optically active compound having silicon as the asymmetric atom, the author takes up the production of silicones in America since 1945. The silicones are produced by the hydrolysis of intermediate organic-halogen-silicon compounds, these in turn being produced from silicon tetrachloride and alkyl magnesium salts in a Grignard reaction. The details of the production are discussed.

Diesel Power and Diesel Transportation, Vol. 27, No. 4, April, 1949

DIESELS VERSUS GASOLINE ENGINES FOR TRUCKING OPERATIONS
Willett, H. L., Jr.—pp. 66-69

The author presents a new method for comparing the two types of power plants for trucking operations. His "cut-away" method of evaluating truck costs takes into account: 1. Variations in cost of the same vehicle operating under different conditions. 2. Variations in cost between different vehicles even though they are operating under identical conditions. 3. Variations in costs due to the demand for service by the operating department even though the units and operating conditions are constant.

DIESEL ENGINE SPECIFICATIONS, 1949
Anon.—pp. 73-102

Extensive tabulated data are presented on Diesel engines manufactured by various American Diesel engine builders and on imported Diesel engines (five foreign firms).

Vol. 27, No. 5, May, 1949

STATISTICS ON RAILROAD DIESELIZATION. FACTS AND FIGURES ILLUSTRATING THE GROWTH AND PRESENT STATUS OF DIESEL-ELECTRIC LOCOMOTIVES
Anon.—pp. 34-37

Statistical diagrams presented give comparisons of the numbers of Diesel-electric locomotives on hand and on order by district and type of service. An additional diagram compares locomotives by type of power (steam and Diesel-electric locomotives). This diagram covers the 1929-1949 period.

DIESEL ENGINE MAINTENANCE
Lodge, S. E.—pp. 38-41

This is an abstract of the paper presented by the author at the Twenty-first Annual Meeting, Gas and Oil Power Division, ASME, held at Chicago, Illinois, 1949. The author describes the procedure used by the American Locomotive Co. in instructing railroad personnel in the construction and maintenance of the Diesel engine. A good description of the engine is given. Emphasis is placed among other features on the design of the engine.

STATUS OF DUAL-FUEL ENGINE DEVELOPMENT
Boyer, R. L.—pp. 52-58

An abstract of the paper presented by the author at the SAE Annual Meeting, Detroit, Michigan, Jan. 10-14, 1949 is presented. The Diesel Engine Manufacturers Association officially defines a dual-fuel engine as one which uses all oil fuel on the Diesel cycle, or predominately gaseous fuel with oil ignition and is fully convertible from one to the other. On the other hand, it officially defines a gas-Diesel as a dual-fuel engine which is not immediately convertible. The purpose of this paper is essentially to describe the development of the dual-fuel engine, what it can do and is doing, and to show its rightful place in the field. General description, controls, performance, economics and applications are covered.

Ethyl News, May, 1949

THE PLUS IN PREMIUM GASOLINE
Frey, J. J.—pp. 3-8

The paper was presented before a meeting of the American Petroleum Institute Marketing Division in St. Louis, Missouri, on May 10th. Portions of it are reprinted. Table 1 shows octane number requirement in terms of primary reference fuels. Figures 1 and 2 show trends in antiknock quality. Figures 3 and 4 show trends in volatility. Figure 5 shows average effect of variables on octane number requirement. Figure 6 shows effect of fuel tetraethyl lead content and test mileage on change in octane number requirement. The subjects mentioned are discussed.

(*Continued on page* 198)

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(*Continued from page* 179)

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Some Aspects of Diesel Cylinder Lubrication

(*Continued from page* 183)

liness are the heavy duty oils. Such oils are additive treated to increase oxidation stability and to improve their detergent-dispersive characteristics. The exact mechanism by which detergent compounds in the oil prevent the deposition of the products of oil deterioration as well as products of incomplete combustion of the fuel is as yet unknown, however, their effectiveness in minimizing ring sticking is well known. Were these detergent oils unavailable, the prevention of ring sticking in certain existing diesel engines would be difficult. The effectiveness of heavy duty oils in slow speed engines has not been so pronounced. In many such engines piston deposits are frequently no greater, sometimes less, with straight mineral oils. Low speed engines often indicate a preference for a particular type of straight mineral oil. High viscosity index oils with their greater stability give excellent performance in some engines while others prefer the lower viscosity index oil with its greater natural detergency, lower carbon forming tendencies, and lower volatility.

Since no simple laboratory test has yet been devised to evaluate an oil's ability to maintain an engine interior free of deposits, the industry relies upon laboratory engine tests and controlled field tests to furnish the final answer to an oil's effectiveness in this regard.

As is so often true, technological and engineering advances in the field of cylinder lubrication have proceeded at a pace exceeding that at which our understanding of the basic scientific aspects of the process has progressed. Engineers have effectively solved many perplexing problems related to cylinder lubrication. The trend toward highly supercharged diesel engine, higher speeds, smaller and lighter engines, and the interest in the use of lower grade cheaper diesel fuels promise to present new and challenging problems, solutions to which will be obtained through the application of the engineering skill of the engine designer and the lubrication engineer aided by a broadening base of fundamental knowledge of the mechanism of cylinder wear, cylinder lubrication and lubricating oil behaviour.

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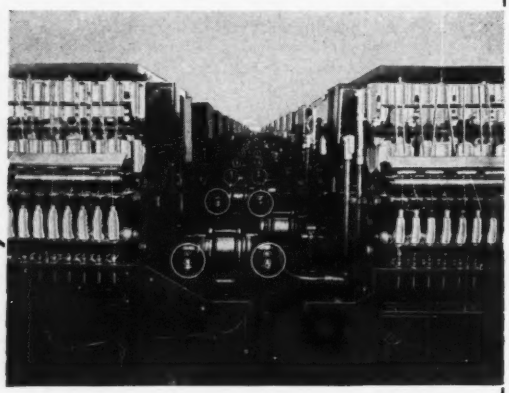

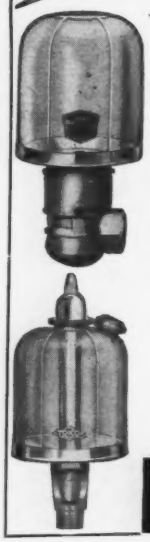

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(*Continued from page* 196)

The Institute Spokesman, Vol. 13, No. 1, April, 1949

MODERN DEVELOPMENTS IN FATS FOR GREASE MANUFACTURE
Lacey, F. E.—pp. 7-9-11

Figure 1 shows 1947 figures on millions of pounds of fatty constituents used in making greases. Tallow and grease are still the most important fatty constituents for lubricating grease. Fats are perhaps as complex as any naturally occurring substance being made up of the 21 fatty acids and distributed throughout each type of fat in a more or less random Tri-glyceride look-up. Separating them into their components is a difficult job, requiring very closely controlled processes. In the late 30's and early 40's the Solvent Crystallization principle, developed by the Petroleum Industry and used extensively in dewaxing petroleum oil, was applied to the fatty acid industry and has been well accepted. This process provides an increased efficiency of separation, doing the general pressing job more efficiently. Flow diagrams are shown for Solexol process, propane crystallization, destearinization of menhaden fish oil. In Solex process fat or fatty acid being fractionated is introduced in the middle of the fractionation tower and propane near the bottom. Temperatures are just under the critical point for propane (260°F.), pressure 600 pounds. Figure 5 shows how the Solexol process replaces distillation. Figure 6 illustrates still another method of making fatty acids by selectively dissolving the free fatty acid fraction of Brown Grease and leaving the Tri Glyceride fraction unchanged.

ALL-PURPOSE GREASES
Kipp, E. M., and Bunting, J. T.—pp. 16-17, 19-20

An ideal grease would be one whose operating characteristics would leave nothing to be desired in any type of application which would normally employ a grease as a lubricant. As of the present, variations in equipment and operating conditions have necessitated the use of various types and grades of greases. The consumer of grease products is directly interested in the development of greases which will permit as small a number as possible of greases to be used, commensurate with adequate performance. A recent survey of the grease lubrication practices in the various plants of the Aluminum Company of America disclosed that some 135 different brand name products were in use. This number of greases is far in exceses of that required for satisfactory lubrication. Several of the more promising types of industrial "all-purpose" greases have been selected for extensive field scale evaluation. The barium soap type all-purpose grease has been among the more promising. The barium base grease represents only one of several potentially useful types of greases.

SYNTHETIC-100 EXTREME JELL ALUMINUM STEARATE
Adv. of Synthetic Products Co.—p. 18

Advantages of Synthetic-100 (extreme jell aluminum stearate) are: highest yield (non-bleeding lubricants with all oils) best penetration tests (both worked and unworked), higher melting grease obtained, savings because less is used and uniform laboratory checked production.

Vol. 13, No. 2, May, 1949

SOAP ANTIOXIDANT
Anon.—p. 13
(Can. 454,025)

A patent issued to National Oil Products Company discloses a method for obtaining an antioxidant from soap by contacting the soap with ethylene dichloride in which the antioxidant dissolves.

FLUOROLUBES
Anon.—p. 15
J. Commerce, March 29, 1949, p. 3A.

Hooker Electrochemical Co. is producing a series of polymerized perfluorovinyl chlorides ranging from heavy grease-like substances through thin oil materials. They are said to be very stable to heat and powerful oxidizing chemicals.

THE IMPORTANCE OF PROPER LUBRICANTS FOR FARM MACHINEY
Gjerde, M. D.—pp. 16-17, 19

In early farm equipment, lubrication was not of major concern. The present discussion is confined to the greases required for proper lubrication of modern farm machinery. The widespread use of greases for this service is due, primarily, to the improved method of applying them through suitable fittings by pressure gun application. The lubrication needs of farm tractors and the machinery powered by them form the basis for the characteristics and the performance quality stated as desirable for the greases to possess.

OILS AND LUBRICANTS PATENT ABSTRACTS

Printed copies of patents are available from the Patent Office at twenty-five cents each. Address the Commissioner of Patents, Washington, D. C., for copies and for general information concerning patents.

From Official Gazette—Vol. 622, Nos. 1, 2, 3, 4, 5. Vol. 623, Nos. 1, 2, 3, 4.

Prepared by ANN BURCHICK

Bleaching Oils and Fats—Patent #2,468,753—Lloyd F. Henderson and Louis H. Libby, assignors to Lever Brothers Co.

A process of bleaching dark colored oil and fat stocks, which comprises treating said stock with an acidic phosphoric compound selected from the group consisting of orthophosphoric acid, pyrophosphoric acid and acidic salts thereof, and oxygen in the presence of a silicate radical containing inhibitor.

Hydrogenating Fat—Patent #2,468,799—Norbert W. Ziels and Werner H. Schmidt, assignors to Lever Brothers Co.

A method of producing a fat solid at room temperature but substantially liquid at body temperature, which comprises hydrogenating a normally liquid glyceride oil selected from the group consisting of peanut oil, cottonseed oil and soy bean oil, with a nickel catalyst containing 1.38 to 5% sulfur based on nickel, at a temperature of 130 to 250°C., and at a pressure of 5 to 100 pounds per square inch hydrogen.

Core Oils—Patent #2,468,956—Martin S. Burg, assignors to Socony-Vacuum Oil Co., Inc.

A method for forming sand cores which comprises mixing sand with a core oil comprising a predominant quantity of a drying oil and a minor amount, not more than about 10%, of a viscous, substantially saturated hydrocarbon polymer of alkene-1 hydrocarbon, said polymer having a flash point above about 450°F., molding the resultant mixture and baking the molded mixture.

Lubricating Oil Compositions—Patent #2,469,003—Albert G. Rocchini, assignor to Gulf Research & Development Co.

A lubricating oil composition essentially comprising a major proportion of a hydrocarbon oil of lubricating viscosity and between about 0.1 and about 5.0 per cent by weight of the composition of an oil-soluble polyvalent metal salt of naphthenoxy-stearic acid.

Production of Oil—Patent #2,469,354—Donald C. Bond, assignor to The Pure Oil Co.

The method of increasing the flow of oil from a subterranean oil producing formation containing a plurality of earth bores comprising, injecting into at least one of said bores a substantially dry carrier gas containing about one volume of the vapor of a readily volatile hydrolyzable halosilane per 5,000 to 10,000 volumes of the dry gas, which vapor upon contact with moisture in the earth formation hydrolyzes to deposit on solid particles comprising the formation of a film preferentially wettable by oil.

Method of Lubricating Metal Surfaces During Cold Working—Patent #2,469,473—Gilbert H. Orozco and John A. Henricks, assignors to Gilron Products Co.

In the cold working of metals, the improvement comprising: stepwise lubrication of the working surface of the tool by simultaneously supplying between the work and tool dry organic low melting point lubricating-film-forming and water liberating material and a plurality of dry inroganic hydrated glass forming materials having melting points below 1000°C. and selected to provide, stepwise, a range of melting water liberating and glass fusion points all below the welding point of the metal and tool.

Synthetic Lubricating Oil Production—Patent #2,469,725—Raymond L. Heinrich, assignor, by mesne assignments, to Standard Oil Development Co.

A method for producing an improved lubricating oil which includes the steps of subjecting a first mixture including alpha and beta olefins and alpha tertiary olefins to a separation treatment to obtain a second mixture of alpha mono-olefins and alpha tertiary olefins, subjecting the second mixture of alpha mono-olefins and alpha tertiary olefins to polymerization conditions in the presence of a polymerization catalyst to form a polymer in the lubricating oil boiling range, separating the polymer from the catalyst and recovering a product suitable for use as a lubricating oil.

Cracking Oil with Aerogel Catalysts—Patent #2,469,735 — Kenneth K. Kearby, assignor to Standard Oil Development Co.

Process for cracking petroleum oil to produce motor fuel having high anti-knock properties comprising intimately contacting the oil to be cracked while at a cracking temperature with a metal oxide catalyst in the form of an aerogel.

Soluble Cutting Oil Base—Patent #2,469,741—Arnold J. Morway and John C. Zimmer, assignors to Standard Oil Development Co.

The method of producing a sulfurized cutting oil base which comprises treating a crude dark colored aliphatic ester of hydrogenated rosin acids with 0.1 to 2.0% of a phosphorus chloride by weight, based on said ester, at a temperature of approximately the boiling point of said phosphorus chloride, for a period of time sufficient to substantially clarify said ester, and thereafter reacting said clarified ester with 8 to 15% flowers of sulfur at a temperature of 300 to 400°F. for a period of ½ to 2 hours.

Oil Addend—Patent #2,470,276—Franklin M. Watkins, assignor to Sinclair Refining Co.

A petroleum oil, normally corrosive to copper by reason of its content of sulfur, containing an amount of tertiary-butyl hydroperoxide sufficient to inhibit such corrosion.

Mineral Oil Compositions—Patent #2,470,537—Stanley P. Waugh, assignor to Tide Water Associated Oil Co.

A lubricating composition suitable for use under aqueous conditions and characterized by forming upon admixture with water a water-in-oil emulsion having lubricating properties which comprises a mineral oil in major proportional amount having dissolved therein (a) at least about 1% but less than about 15% by weight of a blown semi-drying fatty oil and (b) about 0.05 to about 1.0% by weight of (1) a hexitol anhydride partially esterified with a fatty acid of at least 12 carbon atoms and (2) about 0.05 to about 1.0% by weight of a polyoxyalkylene derivative of a hexitol anhydride partially esterified with a fatty acid of at least 12 carbon atoms.

Method for Obtaining Fat-Soluble Vitamin-Containing Materials in Oil—Patent #2,470,703—Charles J. Kern and Joseph M. Tabor, assignors to American Home Products Corp.

The process of treating a vitamin-containing oil selected from the group consisting of fish and animal oils to extract its vitamin content and to obtain a highly potent concentrate therefrom comprising saponifying the oil and extracting the vitamin content with a mixture comprising an organic solvent in which fat-soluble vitamins are soluble and an oil selected from the group consisting of vegetable and mineral oil, the oil in said mixture being present to the extent of abou 0.05% to 5% by weight of said solvent.

Manufacture of Grease—Patent #2,470,965—Harold A. Woods, Wallace J. Yates, and Leendert Klingen and Robert C. Barton, assignors to Shell Development Co.

In a process of preparing alkali and alkaline earth metal soap greases, wherein the hot grease is rapidly and uniformly cooled, the improvement which comprises forcing the hot liquid state grease from an enclosed heating and mixing zone directly into a zone of restricted cross-section having a thickness of not more than about 4 inches and cooled by suitable means, said grease being kept in said cooling zone and cooled statically therein substantially at a uniform and uninterrupted rate for a period sufficient for the grease to form a pronounced gel structure throughout and have a desired texture and uniform consistency.

Lubricating Oil—Patent #2,471,115—Louis A. Mikeska, assignor to Standard Oil Development Co.

A method of preparing an oil soluble additive for mineral lubricating oils which comprises reacting a mixture of paraffin wax-phenol and an unsubstituted aliphatic monohydroxy alcohol containing 1 to 18 carbon atoms, such mixture having 1 to 2 wax-phenol hydroxyl groups for each molecule of alcohol, with a sufficient amount of phosphorus pentasulfide to convert the phenol and alcohol present into dithiophosphoric acids, and further converting the product thus formed with an oxidizing agent selected from the group which consists of potassium triiodide, sulfur dichloride, and sulfur monochloride capable of converting the same into a polysulfide.

Rust Preventive Compositions—Patent #2,471,638—Paul R. McCarthy, assignor to Gulf Research & Development Co.

An improved liquid rust preventive composition adapted to form a water-impervious film on metal surfaces consisting essentially of a mineral oil having a viscosity within the range of from about 100 seconds to about 500 seconds at 100°F., and containing 5 to 15 per cent, by weight, of petrolatum wax, 1 to 2 per cent, by weight, fo an oil-soluble wetting agent, and 1 to 2 per cent, by weight, of blown soya oil having a viscosity of about 1900 seconds to about 2000 seconds at 210°F.

Oil-Resistant Composition—Patent #2,471,870—Philip T. Gidley, assignor, by mesne assignments, to Standard Oil Development Co.

As a new composition of matter a curable mixture consisting of: 100 parts of a rubbery butadiene acrylonitrile copolymer, 100 parts of a resin selected from the group consisting of polyvinyl formal, polyvinyl acetal and polyvinyl butyral; about 10 parts of zinc oxide; about 2 parts of sulfur; about 45 to 50 parts of tricresyl phosphate; about 1.5 parts of a vulcanization accelerator; about 72-95 parts of a filler and 0.5 to 2 parts of anti-oxidant.

Rust-Inhibiting Coating Compositions—Patent #2,472,099—Loy S. Engle and Walter Fikar, assignors to Interchemical Corp.

A rust-inhibiting composition, consisting essentially of the reaction product obtained by heating together, to about 150°C., a heat-bodied glyceride oil and an acid alkyl phosphate, dissolved in a volatile solvent, there being present from about ½ to 10% by weight of alkyl phosphate, heat-bodied glyceride oil in at least approximately as great quantity as the phosphate, but not exceeding about 30%, and 70% or more of volatile solvent.

Lubricating Oil Compositions—Patent #2,472,503—Johan Leonard van der Minne, assignor to Shell Development Co.

A mineral lubricating oil having incorporated therein, in an amount sufficient to inhibit oxidation and corrosion, an oil-soluble polyvalent metal salt of an acidic aromatic compound selected from the group consisting of phenols and aromatic carboyxlic acids and a saponifiable oxidation product of a polymeric olefin of lubricating oil viscosity, said oxidation product being obtained as follows: polymerizing an olefinic hydrocarbon material of boiling range of from about 100°C. to about 300°C. to produce a synthetic polymeric olefin hydrocarbon oil of lubricating oil viscosity and oxidizing said synthetic hydrocarbon oil at a temperature between about 150°C. to 200°C. with an oxygen-containing gas for sufficient time to partially oxidize the synthetic hydrocarbon oil while avoiding breakdown thereof.

Treatment of Oils Corrosive to Copper—Patent #2,473,195 — Charles A. Cohen, assignor to Standard Oil Development Co.

A process for preparing petroleum hydrocarbon oil non-corrosive to copper, said oil having been treated with strong sulfuric acid, the sludge having been removed, the acid-treated oil having been neutralized with a neutralizing agent, the product of neutralization having been extracted with an immiscible solvent, and the residual immiscible solvent having been removed from the oil, and the resulting oil having been treated with clay, which comprises treating the said oil with an aqueous solution of a normal alkali metal sulfite.

Pour Point Depressant for Oil Compositions—Patent #2,473,370—Russell J. Hawes, William F. Behrman, and Charles A. Campbell, assignors to Tide Water Associated Oil Co.

A method for preparing a composition, adapted for depressing and stabilizing the pour point of a mineral oil having an undesirably high and unstable pour-point, from a solid subdivided adsorbent containing color-imparting carbonaceous bodies adsorbed from a fraction obtained by fractional distillation without substantial cracking, of a mineral oil, which comprises (a) extracting from said adsorbent color bodies adsorbed from said oil which are readily displaceable from said adsorbent by purging from said adsorbent with steam but not substantially removable from said adsorbent by non-aromatic naphtha and (b) substantially cracking the extract thus obtained to obtain residuum effective as a pour point depressant and pour point stabilizer when incorporated in a minor proportional amount by weight in a mineral oil having an undesirably high and unstable pour point.

Treatment of Crude Petroleum Oil—Patent #2,473,431—Charles O. Hoover, assignor to Air Reduction Co., Inc.

In the distillation of naturally occurring petroleum crude oil, the step of reducing the corrosiveness of the oil resulting from the presence of comoounds naturally occurring therein which are unstable at the distillation temperatures, by

(*Continued on page* 203)

(*Continued from page* 174)

would certainly be difficult. We do not believe that small scale engine tests would be satisfactory. Small one-cylinder gasoline engines are used in experimental development work as a rough screening test, but we are convinced that a simple test such as this cannot be used to predict satisfactory use in a diesel engine and that a user would not be protected by performance specifications based upon such small scale tests. Therefore, it does not appear to be practicable to write a specification which can adequately describe an oil and which can be depended upon to assure performance in use.

Discussion by O. L. Maag

Timken Roller Bearing Co.

Dr. Barr's remarks on waste used for packing car journal bearings and the car oils used on this service turn my thoughts back about 30 years when I was with the Galena Signal Oil Co., who at that time lubricated over 90% of the railway car miles in the U.S.A. At the time, we used lead soap car oils and it was necessary to blend the car oils so that they would feed properly through the waste. The correct grade of waste was also necessary, otherwise, excessively hot boxes occurred. The oil companies have been blending oils without lead soaps to take care of these journal bearings. However, with the increased loads and speeds, Dr. Barr informs us, our lubrication problems are getting more difficult and troublesome and we are encountering more hot boxes. As he states, the roller bearing has apparently been the answer to these problems on passenger and Pullman cars, and they have also been very successful on locomotives. These roller bearing cars are being very satisfactorily lubricated with standard car oils.

With the idea of lengthening the time between inspections and thus saving labor, the Union Pacific Railroad has equipped a fleet of cattle cars with roller bearings designed for grease lubrication and these have been in service with good results for around a year. Since greases are to be used, I wish to point out some of the advantages of grease over oil and also the advantages of oil over grease.

We know that antifriction bearings can be lubricated with grease or oil and that bearing closures and operating conditions are the factors that determine the type of lubricant.

On the first railway roller bearing installation, the Timken Company used No. 2 penetration soda soap greases, as we felt the closures would not retain oil. We ran into the difficulty of the grease channeling and the bearings burning up for lack of lubrication so we changed to heavy-bodied mineral oils, cylinder oils and summer car oils. Finally, we found that the light car oils were satisfactory as far as lubrication was concerned. Over lubricating has been a problem that has increased the lubrication costs even though it is quite easy to measure the oil level in the boxes.

In order to be safe from grease channeling, the Timken Company has recommended O-penetration greases compounded from good quality mineral oils having the viscosities and cold tests of car oils. Sodium soap greases are predominantly used although we are experimenting with both lithium and barium soap products.

I believe we will all agree that oils are more stable from oxidation than greases. Railway car oils are being mixed today without any harmful results. The various greases may be mixed without detrimental results; however, this has yet to be proved. If freight cars are to be equipped universally with roller bearings, greases that can be mixed in all proportions must be compounded. This is a problem for the grease makers to handle. Greases will likely prove better rust protectors, as they will not drain off the bearings as readily as oils. Also, when water contamination occurs, the water and grease will not rust as rapidly as water and oil since with soda soap greases the water will be emulsified and not free to attack the bearing surfaces. With an excessive amount of water in the bearing housings, the water can be drained off from oil; but with grease, the box will require cleaning and the addition of new lubricant.

In cleaning a bearing housing where oil is used, the housing can readily be flushed with oil and refilled and made ready for use in a short time, whereas with grease it will be necessary to flush with hot oil or disassemble the unit for cleaning. This requires considerable time.

It is quite easy on inspection to measure the oil level in a housing using oil, whereas it is quite difficult with grease since depending on temperatures and grease properties greases will not readily seek a level.

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Since car oils are selling for around 16 cents per gallon or approximately 2½ cents per pound and since greases being used are selling for around 16 to 20 cents per pound, the railroads should consider running tests using better oil seals and then conducting comparative, long-period tests with oils and greases. Over lubricating must be avoided since the excess oil or grease is soon lost.

Dr. Barr gives his experience with detergent motor oils on their Diesel locomotives. It seems quite apparent that the Diesel is replacing the steam locomotive. We still have much to learn regarding the lubrication of the Diesel. There are still two schools of thought as to the proper motor lubricant. Some builders still feel that the nondetergent good quality motor oils with proper filters, etc., are best. Apparently, some time will be required to settle this point.

He also states that some railroads are using straight mineral oils for steam cylinder lubrication. This has been tried several times but invariably they have returned to the compounded valve oils for steam cylinder lubrication.

A.S.L.E. HI-LITES

A.S.L.E. ANNOUNCES BEARING RESEARCH PROJECT

One of the important activities of the Society is that related to the sponsorship and support of cooperative research projects of the nature best suited to this type of approach. As a result of many months of study and effort by the Projects Committee and by other members and officers of the Society, it was formally decided that the Society initiate a cooperative research project on journal bearings. The purpose of this project was to be that of a thoroughgoing review of world-wide literature on journal bearing design with particular emphasis upon lubrication aspects. The purpose of this survey would also be that of providing a critical evaluation of all available data in the literature bearing upon this problem. Also, as a result of this critical analysis, an authoritative opinion was to be developed with regard to that phase of journal bearing lubrication which appears to be in greatest need of further investigation and study, with particular emphasis upon practical problems.

Concise summaries of the more important abstracts were to be provided as well as a comprehensive bibliography of all important references. Comments as to the strong and weak points of experimental methods used in the past and of existing information were also to form an important part of this initial cooperative journal bearing research project.

By secret ballot of the officers of the Society, the project was awarded to the Mechanical Engineering Department of Columbia University, from among numerous interested groups under the supervision of Dr. Dudley D. Fuller. It was estimated that the project would be carried through to completion in about two years and at a cost of approximately $10,000. The Projects Committee of the Society was authorized to establish this fund through the cooperation of industry and other interested groups.

With regard to the financial support required, the Committee wishes to announce at this time that half of the required funds are now available. The following is a list of those firms and other interested groups who to date have contributed generously to the support of this project.

Acme Steel Company
Aluminum Company of America
American Iron & Steel Institute
Ampco Metal, Inc.
Cleveland Graphite Bronze Company
Ford Motor Company
Harnischfeger Corporation
Morgan Construction Company
SKF Industries, Inc.
Thompson Products, Inc.
United States Steel Corp. of Delaware
Chicago Section, A.S.L.E.

To date, $4,900 have been contributed. It is evident that we still have a considerable way to go before fulfilling the $10,000 fund goal. It is felt that this project is a very worthwhile one indeed, and that through such a project the Society can contribute in an effective manner to the field of lubrication engineering and to those other phases associated with it. We earnestly bespeak the further interest and financial support of any concern or other interested group in aiding us to achieve our initial objectives in this cooperative research project.

An Advisory Committee has been established to supervise this project and to assure all interested people of the best possible results for the time, money, and effort to be expended. The members of this Advisory Committee are as follows:

L. M. Tichvinsky, Chr.,
University of California
J. B. Bidwell,
General Motors Corp.
John T. Burwell, Jr.,
Massachusetts Institute of Technology
John Boyd,
Westinghouse Research Laboratories
H. B. Conover,
Carnegie Illinois Steel Corp.
Christian Dantsizen,
General Electric Company
Harvey T. Hill,
Diesel Engine Manufacturers Assoc.
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Morgan Construction Company
E. M. Kipp,
Aluminum Company of America
D. H. Moreton,
Douglas Aircraft Company
J. C. Peebles,
Illinois Institute of Technology
N. C. Penfold,
Southwest Research Institute
E. A. Ryder,
Pratt & Whitney Aircraft Co.

We are pleased to present the new Chairman of the Presidential Council, Mr. George L. Sumner, our most recent past President, who automatically becomes Chairman of the Council. This group of distinguished past Presidents acts in an advisory capacity to the Society, among its duties being the consideration of candidates for nomination to various offices in the Society and the analysis of Society problems. The Council meets with the Board of Directors, and its Chairman has all the privileges of a Director during his year of office and casts the vote for the Council. The Society is fortunate in being able to continue to avail itself of the valued services of Mr. Sumner as Chairman of the Presidential Council.

Mr. Donald E. Whitehead has been appointed Lubrication Engineer of Crucible Steel Company of America, with headquarters in the Oliver Building, Pittsburgh, Pa. Mr. Whitehead was formerly employed by Carnegie-Illinois Steel Corporation in the same capacity.

A.S.L.E. PUBLICATIONS

WEAR AND LUBRICATION
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Technical Adviser: Dr. Dudley D. Fuller,
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Patent Abstracts

(*Continued from page* 199)

intimately admixing with the oil, prior to the distillation thereof, an alkali-metal soap of a water-insoluble organic acid.

Method of Extracting Oils From Fish Material Patent #2,473,453—Ralph F. Shropshire, assignor to Submarine Signal Co.

The method of extracting oils from fish fragments which comprises reducing oil-bearing fish fragments to a pulpy mass, subjecting said mass to compressional wave energy at a power level which produces cavitation within said mass whereby the cell structure of the fish tissues is disrupted, thereafter separating the desired oil from the treated material.

Mineral Oil Compositions and the Like—Patent #2,473,511—George H. Denison, Jr., and Paul C. Condit, assignors to California Research Corp.

A compounded lubricating oil, comprising a petroleum oil of lubricating viscosity and about 0.1 to 2% by weight based on finished oil of dicetyl monotelluride.

Treatment of Crude Oil—Patent #2,473,522—Robert L. Harris, Assignor to The Standard Oil Co.

A method of treating crude oil to enable the formation of a sluge which is pumpable at lower temperatures, which comprises mixing the crude oil with ammonium oleate and allowing the mixture to settle, the amount of the soap being sufficient to cause the sludge which settles to be pumpable at a temperature within the range of 32° to 65°F. but not sufficient to prevent the formation of such a sludge phase.

Aqueous Lubricant — Patent #2,474,325—Thomas T. Rodgers.

A lubricant composition entirely composed of a single-phase homogeneous aqueous solution containing in solution from 0.1% to 10% of amino amide of halogenated stearic acid in 0.1% to 20% of a free amine.

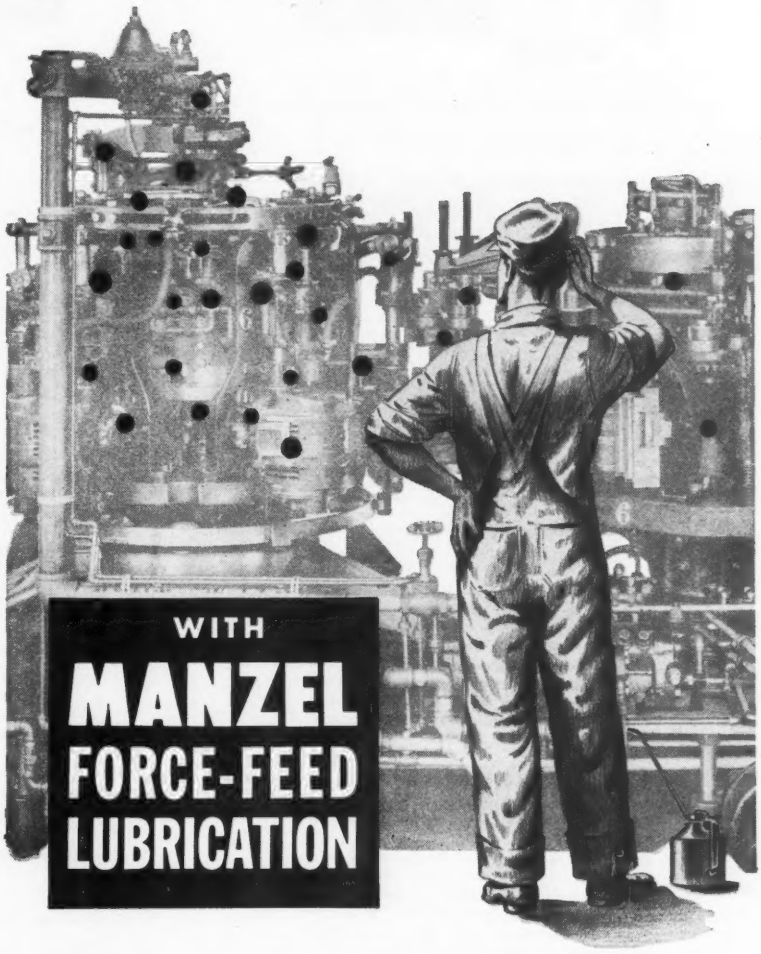
Method of Reclaiming the Hydrocarbon Content of Used Hydrocarbon Lubricants—Patent #2,474,411—Frederick C. Bersworth.

The method of treating used hydrocarbon lubricants and greases to recover the hydrocarbon compounds therein which comprises agitating the said hydrocarbons while in liquid phase for an extended time interval with an aqueous solution containing ethylene diamine tetra-acetic acid and an alkali metal hydroxide in such relative amounts providing not less than two and not over four molar weights of the alkali metal base for each molar weight of the acid and then separating the hydrocarbons from the aqueous solution.

Rust-Preventing Compounds—Patent #2,474,604—Jones I. Wasson and John C. Zimmer, assignors to Standard Oil Development Co.

A composition of the character described consisting essentially of a mineral oil containing 0.01 to 0.1% by weight of an alkyl thioether of a C_2 to C_4 saturated fatty acid wherein the etherifying radical is attached to a carbon atom outside the carboxyl group in said acid, said alkyl radical containing 10 to 24 carbon atoms outside the carboxyl group in said acid, said alkyl radical containing 10 to 24 carbon atoms and 0.1 to 5% of a C_{12} to C_{22} fatty acid ester of a polyhydric alcohol having from 12 to 80 carbon atoms.

CORRECT THESE SPOTS BEFORE HIS EYES!



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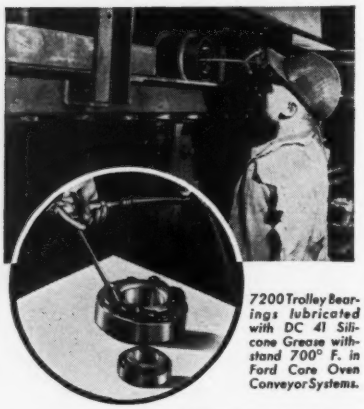
Silicone News

DC SILICONES

Ford Uses Silicone Grease in Bearings at 700° F.



7200 Trolley Bearings lubricated with DC 41 Silicone Grease withstand 700° F. in Ford Core Oven Conveyor Systems.

PHOTO COURTESY FORD MOTOR COMPANY

The cost of designing around the thermal limitations of organic greases is often prohibitive. In such cases, frequent relubrication, high maintenance costs, and production stoppages were inevitable until Dow Corning introduced a line of semi-inorganic silicone greases serviceable at temperatures far above the limits of organic greases.

The economy of this new solution to high temperature lubrication problems is demonstrated in the core oven conveyor systems operated by the Ford Motor Company. These core ovens operate 16 hours a day, 5 days a week, at a peak heat of 700° F. The 7200 trolley bearings are exposed to such temperatures for 2½ hours out of every 4 hours. Even with automatic oiling, the bearings froze, wheels were flattened, and production was interrupted.

After careful testing, Ford's Chemical Engineering Department recommended DC 41 Silicone Grease. Lubricated with this heat-stable silicone grease, the conveyor systems require considerably less power to operate. They start easily and run continuously. Replacement and maintenance costs are greatly reduced and the bearings exposed to 700° F. are relubricated only once a week.

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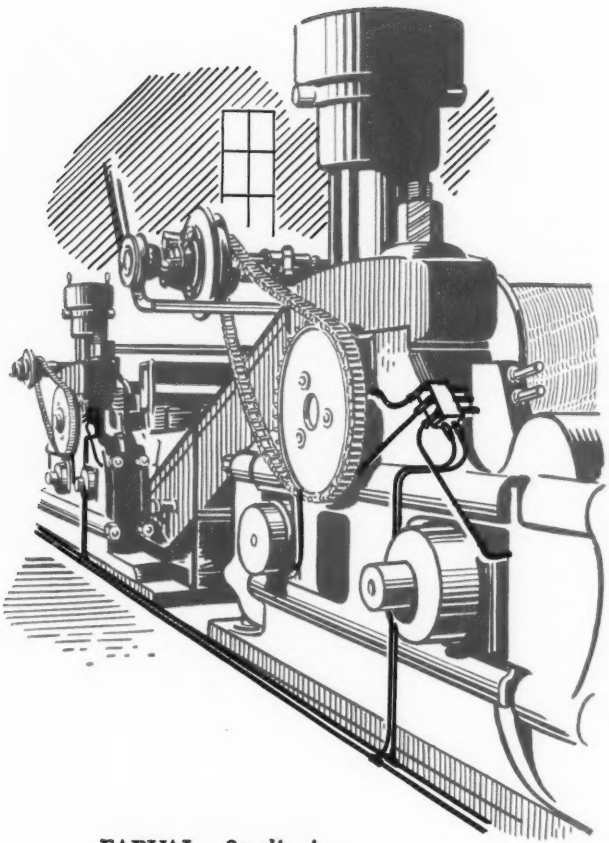
Advertisers IN THIS ISSUE

Acheson Colloids Corp.	159
Alemite	166
Aro Equipment Corp., The	195
Bowser, Inc.	194
Burns Laboratories, Inc.	200
Cincinnati Milling Machine Co.	162
Cuno Engineering Corp.	161
Dow Corning Corp.	204
Farval Corporation, The	Inside Back Cover
Grafo Colloids Corporation	202
Hodson Corporation, The	Back Cover
Houghton, E. F. & Co.	160
Lincoln Engineering Co.	164
Madison-Kipp Corporation	163
Manzel, Inc.	203
Morgan Construction Co.	165
Norgren, C. A., Co.	196
Oronite Chemical Company	192
Shell Oil Company, Inc.	193
Sinclair Refining Co.	197
Stuart, D. A., Oil Co., Ltd.	157
Sun Oil Company	158
Trabon Engineering Corporation	Inside Front Cover
Trico Fuse Mfg. Co.	198

Labor and lubricant saving quickly pays for Farval on sugar mill tandems



FARVAL—*Studies in Centralized Lubrication* No. 105

SUGAR mill lubrication by hand is expensive and unsatisfactory. Roll bearings operate under pressures up to 5,000 p.s.i., and when neglected they heat up quickly. Because the mills must operate continuously, day and night, delays due to hot bearings are a serious problem. The oilers try to avoid shutdowns by literally flooding these bearings with oil.

To eliminate the hit-and-miss hazards of hand oiling and keep bearings well lubricated and cool, mill operators are installing Farval Centralized Lubricating Systems. On one sugar mill tandem, for example, a Farval system has reduced oil consumption to only 3 gallons per 24 hours—netting a saving of $660 for the grinding season on oil alone.

Farval also saves labor. At one Puerto Rican mill, where 3 men were employed to oil a tandem by hand, now only one man is required to supervise lubrication with Farval. At another plant operating a large tandem, no oiler is needed. In short, the money saved on labor and oil alone in one grinding season paid the entire cost of a Farval installation.

In addition to the elimination of hot bearings and mill delays, proper lubrication with Farval helps to maintain correct alignment of rolls, which guarantees maximum juice yield from the cane.

Farval has proven itself in over 20 years of service. It is the original Dualine system of centralized lubrication that others imitate. The Farval valve has only 2 moving parts—is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble. Through its wide valve ports and full hydraulic operation, Farval unfailingly delivers grease or oil to each bearing—as much as you want, exactly measured—as often as desired. Indicators at every bearing show that each valve has functioned. For a full description, write for Bulletin No. 25.

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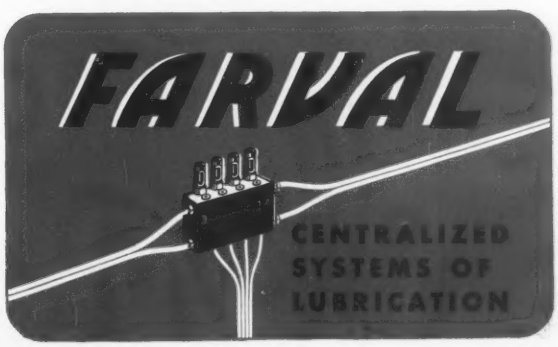

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